SPECTRUM ANALYZER
LA-18A

OPERATION AND SERVICE MANUAL

Lavoie Laboratories, Inc.
MORGANVILLE, NEW JERSEY

SPECTRUM ANALYZER
LA-18A

OPERATION AND SERVICE MANUAL

Lavoie Laboratories, Inc.
MORGANVILLE, NEW JERSEY

TABLE OF CONTENTS

Section		Page
I	GENERAL DESCRIPTION	1
	1-1. Purpose of Handbook	1
	1-3. Purpose and Basic Principles of the Equipment	1
	1-7. Description of Units	1
	1-16. Supplementary Data	2
II	OPERATING PROCEDURES	5
	2-1. General	5
	2-3. Description of Controls	5
	2-5. Sequence of Operation	8
	2-18. Tests Performed with the Spectrum Analyzer	12
	2-20. Analysis of Various Scope Presentations	12
III	OPERATING CHECKS AND ADJUSTMENTS	19
	3-1. General	19
	3-3. Operating checks and Adjustments	19
IV	THEORY OF OPERATION	24
	4-1. General	24
	4-3. Functional Operation of the Analyzer	24
	4-10. Detailed Circuit Analysis	25
	4-11. R-F Tuner	25
	4-12. Oscillators 1 and 2	25
	4-19. Oscillator 3 and Oscillator 4	26
	4-23. 160 MC I-F Amplifier	26
	4-32. Functional Operation of R-F Tuner Controls	27
	4-33. Analyzer Indicator	28
	4-34. Primary Power Distribution	28
	4-37. Spectrum Calibrator	28
	4-41. 64 MC I-F Amplifier	29
	4-47. 1 MC I-F Amplifier	29
	4-56. Sweep Frequency Generator	30
	4-63. Power Supply and Video	31
V	ROUTINE MAINTENANCE	33
	5-1. Plate Voltage Supply	33
	5-2. Spectrum Centering	33
	5-3. Spectrum Width	33
VI	FIELD MAINTENANCE	34
	6-1. Preliminary Procedure	34
	6-2. High Voltage Power Supply	34
	6-3. Power Supply	34
	6-4. Linearity	34
	6-5. Noise Level	34
	6-6. Sweep Frequency	35
	6-7. Video Amplifier	35
	6-8. Spectrum Calibrator	35
	6-9. Spectrum Width	35
	6-10. 160 MC I-F Attenuator	35
	6-11. Amplitude Comparator	38
	6-12. Sweep Frequency Linearity	38
	6-13. Video Detector	38
	6-14. Horizontal Amplifier Linearity	38
	6-15. Tuner Calibration	38
	6-16. Overall Sensitivity	38
	6-17. Spurious Responses	39
	6-18. Trouble Analysis	39

TABLE OF CONTENTS (cont)

Section		Page
VI	6-20. Removal and Replacement of Components	39
	6-21. Voltage and Resistance Charts	41
	6-22. Alignment and Adjustments	41
	6-23. Lubrication	41
VII	DIAGRAMS	53/54
	7-1. General	53/54

LIST OF ILLUSTRATIONS

Figure		Page
1-1	Spectrum Analyzer LA-18A	iv
1-2	Typical Rectangular R-F Pulse Analyzed on Spectrum Analyzer LA-18A	2
2-1	Analyzer Indicator, Front Panel View	9
2-2	R-F Tuner, Front Panel View	10
2-3	Line Trace on CRT with Proper Brightness	11
2-4	Line Trace on CRT with Proper Centering	11
2-5	Line Trace on CRT with Proper Horizontal Gain	11
2-6	Line Trace on CRT with Proper Synchronization	11
2-7	Typical R-F Pulse on CRT before Vertical Gain and I-F Attenuation Adjustments	12
2-8	Typical R-F Pulse on CRT after Vertical Gain and I-F Attenuation Adjustments	12
2-9	R-F Pulse Properly Adjusted	12
2-10	Rectangular Pulse with Neither Amplitude nor Frequency Modulation during the Pulse	15
2-11	Symmetrical Trapezoidal Voltage Pulse with no Frequency Modulation	15
2-12	Symmetrical Triangular Voltage Pulse with no Frequency Modulation	16
2-13	Error-Function Voltage Pulse with no Frequency Modulation	16
2-14	Rectangular Pulse with no Amplitude Modulation during the Pulse, Varying Amounts of Linear Frequency Modulation Present	16
2-15	Linearly Sloped Pulse - 73 percent Amplitude Modulation with no Frequency Modulation	16
2-16	Linearly Sloped Pulse with Linear Frequency Modulation	16
2-17	Trapezoidal Pulse with Trapezoidal Frequency Modulation	17
3-1	Analyzer Indicator, Top View	20
3-2	Spectrum Analyzer LA-18A, Right Side	21
6-1	Analyzer Indicator, Rear View	36
6-2	R-F Tuner, Top View	37
7-1	Functional Block Diagram	55/56
7-2	R-F Tuner	57/58
7-3	Oscillators #1 and #2	59/60
7-4	Oscillator #3 and Mixer	61
7-5	Oscillator #4 and Mixer	62
7-6	Spectrum Calibrator	63/64
7-7	160 MC I-F Amplifier	65/66
7-8	Sweep Frequency Generator	67/68
7-9	64 MC I-F Amplifier	69/70
7-10	1 MC I-F Amplifier (Early Models)	71
7-10A	1 MC I-F Amplifier (Late Models)	72
7-11	Power Supply and Video	73/74
7-12	Indicator Drawer (Early Models)	75
7-12A	Indicator Drawer (Late Models)	76
7-13	High Voltage Supply	77

LIST OF TABLES

Table		Page
I	Technical Data	3
II	Equipment Supplied	4
III	Accessory Equipment	4
IV	Operating Controls	5
V	Examples of Analyzer Uses	13
VI	List of Crystal Diodes	20
VII	Tube Complement	21
VIII	Fuse Complement	23
IX	Voltage Checks	34
X	Tuner Calibration	42
XI	Sensitivity Check for Band 10-150 Megacycles	42
XII	Sensitivity Check for Band 150-350 Megacycles	42
XIII	Sensitivity Check for Band 350-1000 Megacycles	43
XIV	Sensitivity Check for Band 1000-16000 Megacycles	43
XV	Trouble Shooting Chart	44
XVI	1 MC I-F Amplifier Voltage and Resistance Measurements	46
XVII	64 MC I-F Amplifier Voltage and Resistance Measurements	46
XVIII	Sweep Frequency Generator Voltage and Resistance Measurements	47
XIX	Power Supply and Video Voltage and Resistance Measurements	48
XX	Spectrum Calibrator and CRT Voltage and Resistance Measurements	49
XXI	High Voltage Supply Voltage and Resistance Measurements	49
XXII	Oscillators 1 and 2 Voltage and Resistance Measurements	49
XXIII	160 MC I-F Amplifier Voltage and Resistance Measurements	50
XXIV	Connectors, Resistance Measurements	51
XXV	160 MC I-F Amplifier Input Jacks Resistance Measurements	52
XXVI	Quick Check Data for Sensitivity Test of each I-F Amplifier and Video	52

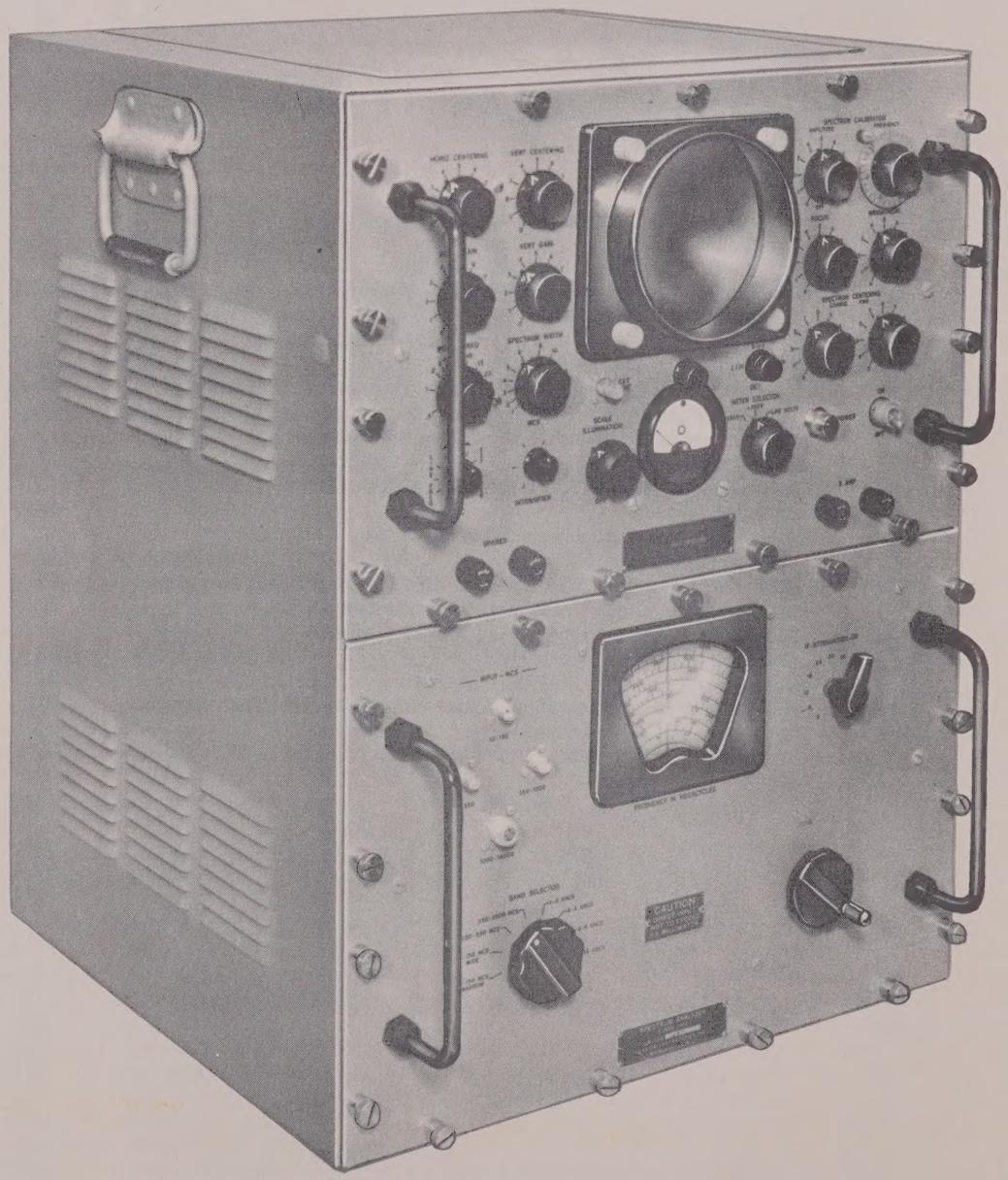


Figure 1-1. Spectrum Analyzer LA-18A

SECTION I

GENERAL DESCRIPTION

1-1. PURPOSE OF HANDBOOK.

1-2. This handbook contains descriptive material and instructions on the operation of the Spectrum Analyzer LA-18A, manufactured by Lavoie Laboratories, Incorporated, Morganville, New Jersey.

1-3. PURPOSE AND BASIC PRINCIPLES OF THE EQUIPMENT.

1-4. The spectrum analyzer is an electronic test instrument used to analyze the frequency spectrum and pulse shape of pulsed r-f oscillators employed in radar transmitters. The instrument can be used to check frequency modulation and frequency stability of an r-f oscillator as well as to measure the pulse and bandwidth of this r-f oscillator pulse. The analysis of pulse shapes is accomplished by viewing the pattern on the cathode-ray-tube (CRT) screen of the analyzer. The pulse pattern represents the distribution in frequency of the r-f power or voltage of the pulse.

1-5. The Spectrum Analyzer, Model LA-18A, consists of a narrow band superhetrodyne receiver-indicator, which is physically divided into two major components: the Analyzer Indicator and the RF Tuner.

The Analyzer Indicator is itself a complete spectrum analyzer with a frequency range limited to 147. 5 to 172. 5 megacycles. When the input signal frequency is 160 megacycles (mid-range), and the spectrum width is set at 10 megacycles, this unit possesses a sensitivity of approximately ten microvolts for a signal + noise-to-noise ratio of two to one.

The RF Tuner is primarily a frequency converter which changes the frequency range of 10 to 16000 megacycles to the basic frequency of 147. 5-172. 5 megacycles required for display by the analyzer indicator. The converted signal from the tuner unit is fed to the indicator unit where it appears as a vertical signal on the baseline of the CRT. This baseline represents a frequency domain. The converted signal is that which is viewed (vertically) on the CRT screen on the panel of the indicator unit. The CRT pattern produced is a plot indicating power or voltage vertically and frequency horizontally and represents the spectrum of an input signal to the Spectrum Analyzer.

1-6. To visually display the desired spectrum, the second local oscillator of the analyzer is swept in frequency while the horizontal deflection of the CRT is varied in synchronism. For a pulsed input signal, a succession of transients appears on the screen which resembles a picket fence, and the envelope of the transients is proportional to the spectrum. For ranges of frequency of the order of 0. 5 to 25 megacycles, the horizontal deflection is accurately proportional to frequency. Figure 1-2 illustrates a one-microsecond rectangular pulse, having negligible frequency modulation, as it appears on the screen of the CRT. The illustration reveals the individual components of the spectrum.

1-7. DESCRIPTION OF UNITS.

1-8. GENERAL. The spectrum analyzer is designed to operate from a 115-volt, 50-400 cps power supply. The power consumption is 250 watts, maximum. The LA-18A is supplied with four internal mixers covering the range of 10 to 16000 Mc.

All frequencies are read on one direct-reading illuminated dial with an accuracy of ± 1 percent at the operating frequency of the local oscillator or its harmonic. The pulse is analyzed on a five-inch CRT. Conventional oscilloscope controls are included to adjust the image for proper analysis. The spectrum width of the pulse can be made to represent a frequency width of from 1/2 to 25 megacycles. A variable amplitude spectrum calibrator (frequency-marker oscillator) with a frequency range of + and - 15 megacycles is provided. The entire instrument is contained in two sliding-drawer units. The two units comprising the analyzer instrument are the Analyzer Indicator and the R-F Tuner. Cable assemblies and two variable r-f attenuators are also supplied.

1-9. ANALYZER INDICATOR.

NOTE

All panel controls referred to in this handbook are spelled exactly as marked on the equipment.

1-10. The analyzer indicator unit constitutes the upper half of the spectrum analyzer instrument. The indicator unit panel primarily consists of a five-inch cathode ray tube, type 5ADP7, and associated controls to aid in adjusting the various wave shapes viewed for proper analysis. The controls used to accomplish this purpose are "HORIZ CENTERING", "VERT CENTERING", "HORIZ GAIN", "VERT GAIN", "SWEEP FREQ", "SPECTRUM WIDTH", SPECTRUM CALIBRATOR", "FOCUS", BRIGHTNESS", "SPECTRUM CENTERING", "SYNCH", and "INTENSIFIER" and 2ND IF Gain. A voltmeter is included on the panel for indicating either the line voltage (115 volts ac input), plate voltage or negative supply potential. The voltages to be read are selectable by use of the "METER SELECTOR" knob. An on-off switch is located on the panel for starting the equipment in operation. Two "3 AMP" input-power fuses are mounted on the panel and can be easily removed and replaced when required. Two spare fuses are provided for maintenance purposes. The "SYNC" control is provided for varying the amplitude of the synchronizing signal, either internal or external. The "INTENSIFIER" control varies the average intensity of the vertical deflection signals on the scope with baseline extinction. A rotary switch provides selection of linear, square law, or log detection. The 2nd IF gain control is used primarily to lower the noise level of the spectrum analyzer.

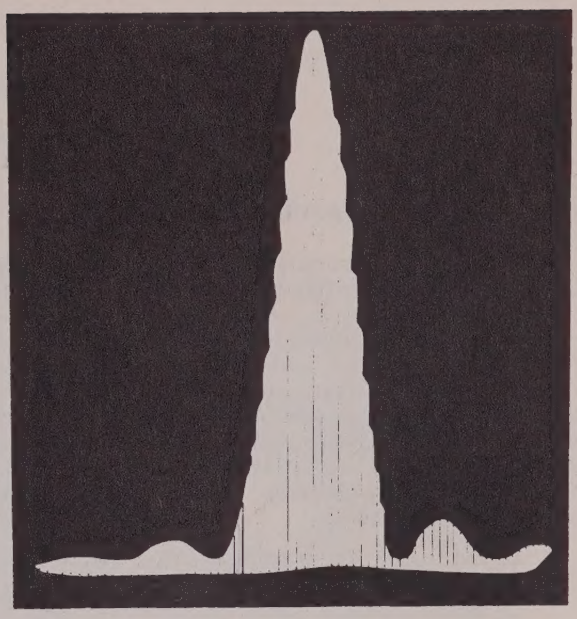


Figure 1-2. Typical Rectangular R-F Pulse Analyzed on Spectrum Analyzer LA-18A

1-11. The interior of the indicator unit primarily consists of a sweep frequency generator strip, spectrum calibrator, two I-F amplifier strips (1 mc and 64 mc), low-voltage power supply, video and sweep circuits, and a high-voltage power supply. Two interior indicator lamps, placed on both sides of the scope screen, provide illumination for the markings on the reticle (the plexiglass assembly mounted in front of the CRT tube face). The intensity of the two indicator lamps is varied by rotating the "SCALE ILLUMINATION" control on the front panel of the indicator unit.

1-12. R-F TUNER.

1-13. The r-f tuner unit constitutes the lower half of the analyzer instrument. The r-f tuner unit panel consists of a direct-reading, illuminated dial, "FREQUENCY IN MEGACYCLES", which displays the frequency range of the local oscillators located in the tuner unit. The frequency of the local oscillators is adjusted by the "TUNE" control and as the "TUNE" knob is varied the dial rotates to indicate the frequency to which the input is tuned. The band of frequencies to be read on the dial is selected by use of an eight position "BAND SELECTOR" switch. The entire range of frequencies of the LA-18A, 10 to 16,000 megacycles may then be tuned. Four input receptacles "INPUT MCS" are included on the panel for connecting the analyzer to the radar or other equipment to be tested. To check the specified range of frequencies desired 10-150, 150-350, 350-1000, 1000-16,000 the appropriate input receptacle must be used. In conjunction with this, the "BAND SELECTOR" knob should be placed on the corresponding frequency range labeled on the panel.

1-14. The interior of the r-f tuner unit primarily consists of three oscillator assemblies, oscillators 1 and 2, and oscillator 3 and oscillator 4, along with the I-F amplifier strip (160 mc). Also included is a gear train assembly which is connected to the "TUNE" control, the "FREQUENCY IN MEGACYCLES" dial, and to the four oscillator assemblies. Thus, during tuning operation, as the "TUNE" control is manipulated, the frequency dial rotates simultaneously with the variable elements in the local oscillators.

1-15. VARIABLE R-F ATTENUATORS. Two variable attenuators are supplied in one housing. One attenuator has a range of 10-2100 mc, the other 1000 to 124000 mc. Both attenuators are of the waveguide-below-cutoff type and operate in the TE1.1 mode (inductive coupling). The output of the attenuators is varied by rotating the control knob.

1-16. SUPPLEMENTARY DATA.

1-17. Data included in this handbook covers model LA-18A. Supplementary data on the Spectrum Analyzer is given in Tables I, II and III. Table I, Technical Data, lists the operating characteristics of the test equipment. Table II, Equipment Supplied, lists the components supplied as part of the analyzer equipment. Table III, Accessory Equipment, lists optional components avialable, which are required to operate the spectrum analyzer to its full capabilities. Each item tabulated indicates the quantity required for a typical installation, component name, and Lavoie part number designation.

TABLE I. TECHNICAL DATA

Frequency Range:	Basic Unit, 10 to 16,000 mc.
Input Terminations:	BNC connector 10 mc to 1000 mc. Type N-1000 mc to 16,000 mc.
Sensitivity:	(For signal + noise-to-noise ratio of 2 to 1 at spectrum width of 0.5 mc.)

Mixer	Frequency Range	Minimum Sensitivity DBM	Termination
Internal	10 to 150 mc.	80	Type BNC
Internal	150 to 350 mc.	80	Type BNC
Int. Coax	350 to 1000 mc.	80	Type BNC
	1000 to 2000 mc.	85	Type N
Int. Coax	2000 to 4000 mc.	75	Type N
	4000 to 8000 mc.	50	Type N
	8000 to 16,000 mc.	50 Nominal	Type N

Spectrum Display:	Signal amplitude on the vertical axis versus frequency on the horizontal axis.
Detection:	Selection of square law, linear or log detection.
Frequency Calibration Accuracy:	±1% at operating frequency of local oscillator.
Spectrum Resolution:	10 kc at all frequencies measured at the 3 db. points.
Frequency Dispersion:	10 to 50 mc . . . . . 500 kc to 5 mc, adjustable. 50 mc to 16 Kmc . . . 500 kc to 25 mc, adjustable.
IF Attenuator:	0-60 db, variable in 6 db. steps, accurate to ±2 db (approx.).
External Attenuator:	Two variable attenuators in one housing provide -100 db. attenuation of input signal over a frequency range of 10 mc to 12.4 Kmc (coaxial).
Spectrum Calibrator:	Provides calibration of ±15 mc marker to accuracy of 0.5 mc.
Sweep Repetition Rate:	0.5 to 30 cps free running or sync. - 1 cpm for recording.
Synchronization:	A panel adjustment of sync sensitivity for internal or external sync.
External Sync:	3.0 peak volts required.
CRT:	Type 5ADP7 supplied.
Reticle:	Illuminated ruled reticle with square law and log scales is provided with a variable illumination control.
Intensifier:	Provides intensification of trace on fast rise and decay and baseline extinction for photographing.
Stability:	Electronically regulated plate and filament supplies are employed to provide the maximum in stability.
Operating Temperature Range:	0 degrees C (32 degrees F) to 55 degrees C (131 degrees F).
Power Requirements:	115 V ±10%, 50-400 cps, 250 watt.
230 Volt Operation:	Connect primaries of control transformer, power transformer, and high voltage transformer in series.
Physical Size:	25-1/8" high, 19-1/2" wide, 18-7/16" deep.

TABLE II. EQUIPMENT SUPPLIED

QUANTITY PER EQUIPMENT	NAME OF UNIT	MANUFACTURERS DESIGNATION
1	Analyzer Indicator	K94000230
1	R-F Tuner	K98800080
1	Instrument Case (dust cover)	K63701470
1	Power Cable - 10 Feet	K81603050
1	Cable, Special Purpose	K81607800
1	Cable, Special Purpose	K81606020
1	Variable R-F Attenuator	K90700070
1	Cable Coax	K81608860
1	Cable Coax	K81609230
1	Handbook	P30010092
1	Cable Coax - 6 Feet	K81606030
1	Cable Coax - 6 Feet	K81601080

TABLE III. ACCESSORY EQUIPMENT

Recorder Output Unit, LA-18AR.	Lavoie Part No. K93100010

Permits aural monitoring of video output, or attaching of graphic recording equipment for permanent record of CRT display.

SECTION II

OPERATING PROCEDURES

2-1. GENERAL.

2-2. This section contains information on the operating procedures to be followed when using the Spectrum Analyzer Model LA-18A as a test instrument. The instrument can be used to check frequency modulation and frequency stability of an r-f oscillator as well as to measure the pulse width and bandwidth of the r-f oscillator pulse. A description is given of all controls to be used in operating the instrument along with the sequence of operation to be followed for performing each test. Typical instrument readings and scope presentations obtained during each test are included,together with any distinguishing features which may assist the operator in identifying the wave shapes presented.

2-3. DESCRIPTION OF CONTROLS.

2-4. Shown in table IV is a list and description of panel controls to be used by the operator when employing the analyzer for testing purposes. All controls are referred to exactly as marked on the equipment. The controls are described in table IV.

TABLE IV. OPERATING CONTROLS

Analyzer Indicator			
Control	Figure and Index No.	Type and Designation	Function
"POWER"	14, figure 2-1	Indicator, I1003	When lit, indicates that input power is being delivered to the analyzer from an external source of a-c supply.
	11, figure 2-1	Switch, S1004	When not in the "OFF" position places the analyzer in operation by feeding the 115-volt, A. C. input to the power supply circuitry. In this position indicator I1003 is lit.
"METER SELECTOR"	15, figure 2-1	Switch, S1002	In the "+150V" position, enables positive supply potential to be read on the voltmeter indicator. In the "-150V" position, enables negative supply potential to be read. In the "LINE VOLTS" position, enables input voltage (line voltage) to the analyzer to be read.
"SCALE ILLUMINATION"	17, figure 2-1	Switch, S1001 Potentiometer, R1003	An on-off switch arrangement with variable resistance control for turning on the scope indicator lamps behind the panel which are used for illuminating the reticle in front of the scope screen. The control is used to vary the intensity of the scope indicator lamps.
"INTENSIFIER"	19, figure 2-1	Potentiometer, R1321	Varies the intensity of only the vertical deflection signals seen on the scope screen.

TABLE IV. OPERATING CONTROLS (cont)

Analyzer Indicator			
Control	Figure and Index No.	Type and Designation	Function
"SYNC"	20, figure 2-1	Potentiometer, R1334	Synchronizes the sweep frequency to a submultiple of the line frequency when rotated in counterclockwise direction, or to the external frequency when rotated in clockwise direction.
"EXT SYNC"	25, figure 2-1	Receptacle, J1012	Used to inject a portion of the external signal, for synchronization. Amplitude is controlled by R1334.
"HORIZ CENTERING"	1, figure 2-1	Potentiometer, R1359	Directs the wave shape in the horizontal direction or X axis on the scope screen. Used to horizontally center the image viewed on the scope.
"VERT CENTERING"	3, figure 2-1	Potentiometer, R1313	Directs the wave shape in the vertical direction or Y axis on the scope screen. Used to vertically position the image viewed on the scope.
"HORIZ GAIN"	24, figure 2-1	Potentiometer, R1350	Narrows or broadens the baseline and image or wave shape viewed on the scope screen to the width of the reticle.
"VERT GAIN"	23, figure 2-1	Potentiometer, R1306	Increases or decreases the amplitude of the image viewed on the scope screen. (Do not operate below 1-1/2 divisions to avoid saturation of square law detector.)
"SWEEP FREQ"	22, figure 2-1	Potentiometer, R1332	Controls the frequency of the sweep as displayed on the scope.
"SPECTRUM WIDTH"	21, figure 2-1	Potentiometer, R1342	Calibrates the entire width of the reticule (10 cm. wide) on the scope screen to represent a bandwidth of 1/2 to 25 megacycles. When analyzing frequencies below 50 mc, and the "BAND SELECTOR" switch is on "NARROW", this control should be limited to a value below the frequency being analyzed.
"SPECTRUM CALIBRATOR"			Presents a pip which acts as a marker on the scope screen. The pip is adjustable in amplitude and frequency permitting measurements within the bandwidth of the 160 mc IF to be made with ease.
"AMPLITUDE"	5, figure 2-1	Potentiometer, R1014	"AMPLITUDE" control varies the amplitude of the marker pip and shuts it off.
"FREQUENCY"	6, figure 2-1	Variable Capacitor, C1403	"FREQUENCY" control varies the frequency (and therefore, position of the pip).

TABLE IV. OPERATING CONTROLS (cont)

Control	Figure and Index No.	Type and Designation	Function
Analyzer Indicator			
"FOCUS"	7, figure 2-1	Potentiometer, R1006	Controls the sharpness or distinction of the image displayed on the scope screen for viewing purposes.
"BRIGHTNESS"	8, figure 2-1	Potentiometer, R1004	Used to vary the brightness of the pulse or any deflection pattern seen on the scope.
"SPECTRUM CENTERING"			Changes the frequency spectrum electronically to center of reticle.
"COARSE"	9, figure 2-1	Potentiometer, R1017	"COARSE" control varies the spectrum frequency in a coarse manner.
"FINE"	10, figure 2-1	Potentiometer, R1018	"FINE" control varies the spectrum frequency in a fine manner.
"DET; LIN, LOG SQ"	27, figure 2-1	Switch, S1005	Permits selection of linear, square law log detection.
"2nd IF GAIN"	26, figure 2-1	Potentiometer, R1025	Used to vary the gain of the 64 mc I-F amplifier. Gain increases in clockwise direction.
"3 AMP"	12, 13, figure 2-1	Fuses, F1001, F1002	Protects the analyzer instrument against overload.
"SPARES"	18, figure 2-1	Spares, Fuses, F1001, F1002	Spare fuses to be used in the event the "3 AMP" fuses become defective.
"VIDEO OUT"	2, figure 2-1	Receptacle J1013	Permits graphic recording of display on CRT, or aural monitoring (zero beating) of signal.
		Analyzer Tuner	
"FREQUENCY IN MEGACYCLES"	5, figure 2-2	Dial mechanically connected to the shaft of the "TUNE" control	Indicates frequency of signal to which analyzer is tuned. Dial rotates as "TUNE" control is varied clockwise or counter-clockwise.
"TUNE"	7, figure 2-2	Knob connected by gearing to variable capacitors C2503 and C2517 in oscillators 1 and 2 and moving pistons in oscillator 3 and oscillator 4.	Used to adjust the frequency of the signal to which analyzer is tuned. By rotating the "TUNE" control capacitors C2503 and C2517 and the moving pistons vary to change the oscillator frequency.
"BAND SELECTOR"	8, figure 2-2	Selector Switch, S2001	Used to select the frequency band desired for analyzing.
"INPUT-MCS"	1, 2, 3, 4, figure 2-2	Receptacles:	Signal input receptacles used for connecting the analyzer instrument to the equipment to be tested.
"10-150"	1, figure 2-2	J2004	Input receptacle used for analyzing frequencies between 10 and 150 mc.

TABLE IV. OPERATING CONTROLS (cont)

Analyzer Tuner			
Control	Figure and Index No.	Type and Designation	Function
"150-350"	2, figure 2-2	J2005	Input receptacle used for analyzing frequencies between 150 and 350 mc.
"350-1000"	3, figure 2-2	J2006	Input receptacle used for analyzing frequencies between 350 and 1000 mc.
"1000-16, 000"	4, figure 2-2	J2007, with coax mixer 1-16	Input receptacle used for checking frequencies between 1000 and 16, 000 mc.
"I-F ATTENUATION DB"	6, figure 2-2	Selector Switch, S2002	Controls attenuation of output of 160 mc i-f amplifier.

2-5. SEQUENCE OF OPERATION.

2-6. Plug the analyzer power cord into an external supply of 115 volts, 50 to 400 cps, ac.

2-7. Throw on the "POWER" switch (11, figure 2-1) to start operation of the equipment. Observe the "POWER" indicator lamp (14). When lit, indicates power on.

2-8. Rotate the "METER SELECTOR" knob (15, figure 2-1) to "LINE VOLTS". Observe the indicated voltage reading on the voltmeter (16). It should read approximately 115 volts.

2-9. Observe the scope screen for a few seconds until a line trace appears. If no trace appears rotate "BRIGHTNESS" control (10, figure 2-1) clockwise. Normal position of this control is about "5". An example of the scope trace to be expected is shown in figure 2-3.

2-10. Adjust "HORIZ CENTERING" knob (1, figure 2-1) and the "VERT CENTERING" knob (3) to place the trace on the base line or X axis of the reticle. Normal position of both these controls is at "5". The appearance of the trace should be as indicated on figure 2-4.

2-11. Adjust "HORIZ GAIN" (24, figure 2-1) to make display 10 centimeters wide on reticle. Adjust the "SWEEP FREQ" control (22) to the desired frequency. With these adjustments made, the trace must appear as shown in figure 2-5.

2-12. Adjust the "SYNC" (20, figure 2-1) potentiometer to synchronize the display on the CRT screen. Adjust "FOCUS" control (7) for sharpness of trace. See figure 2-6 for proper synchronization of trace.

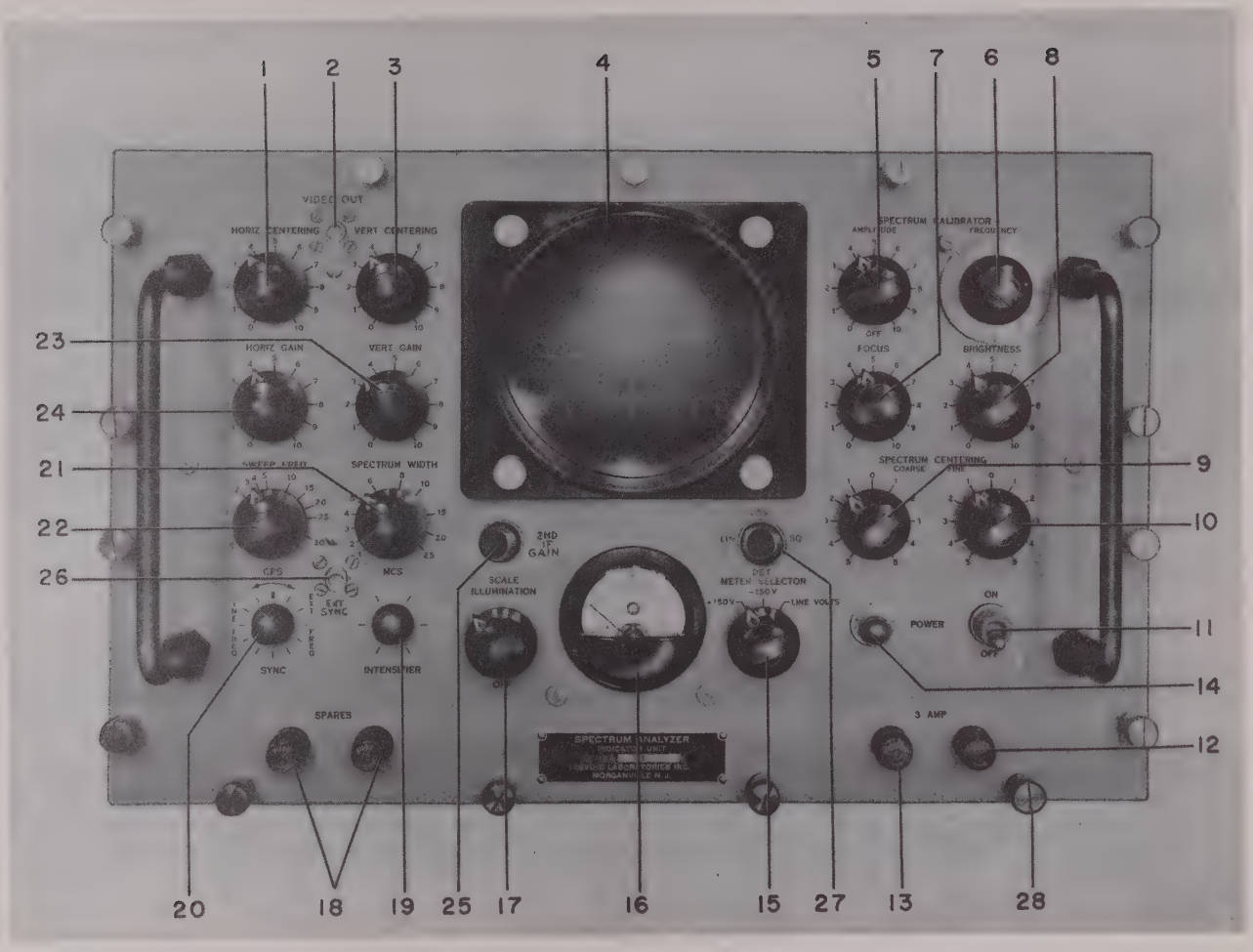
NOTE

Make certain that the sweep rate is not set off by a submultiple of the line frequency. It may be necessary to adjust the "SYNC" control to lock the sweep rate.

2-13. Connect the r-f cables to the appropriately marked receptacles "INPUT-MCS" (1, 2, 3, 4, figure 2-2) on the r-f tuner panel, and to the equipment to be tested.

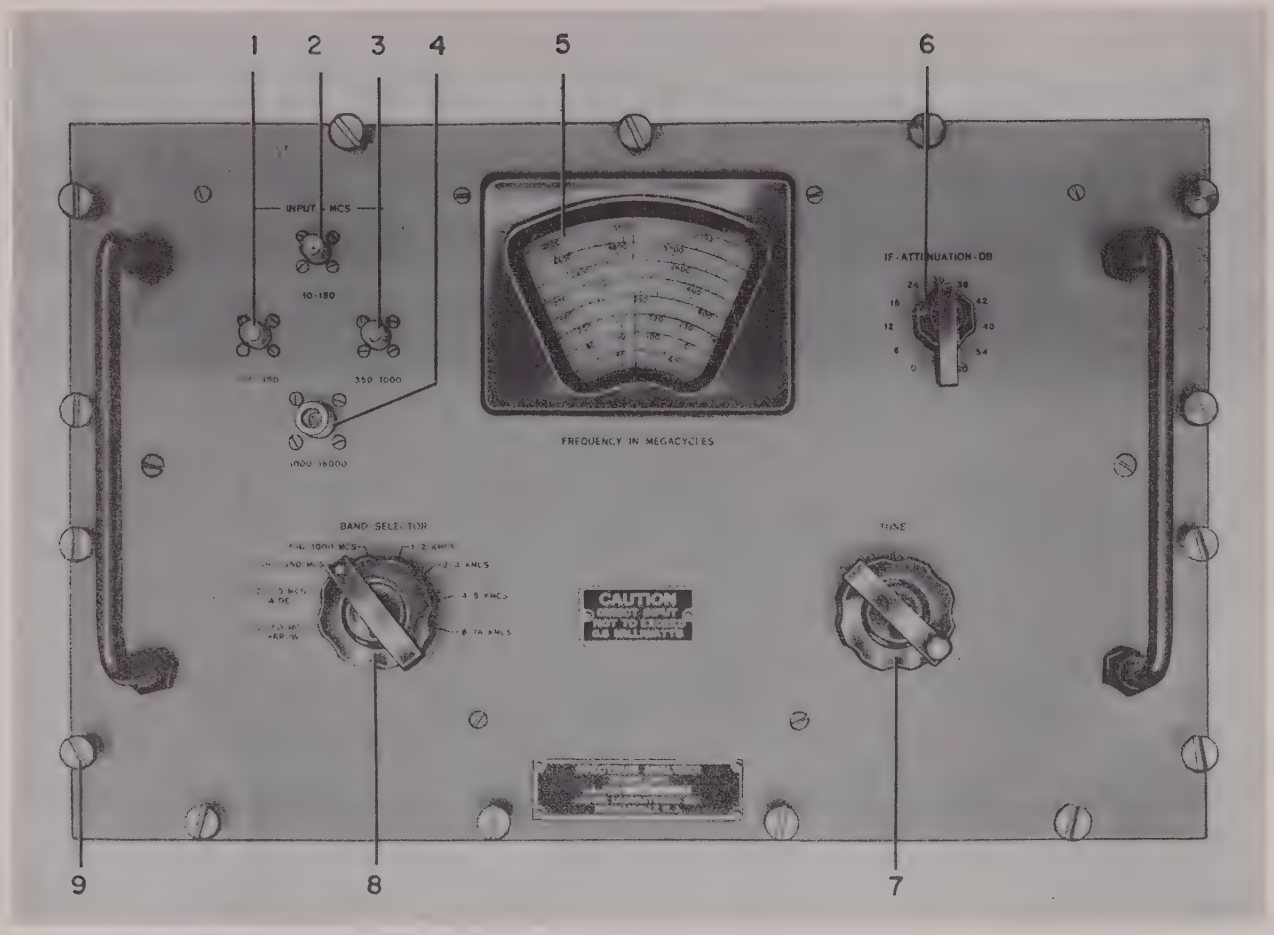
CAUTION

One of the two Variable R-F attenuators must be used whenever it is determined that the input signal is in excess of 5 milliwatt. If the input signal level cannot readily be determined, exercise care by connecting the attenuators prior to performing signal analysis checks on the analyzer instrument. If it is then determined during instrument operation that insufficient signal is being received, the attenuators may be removed. See paragraph 2-18 for procedures concerning use of the attenuators.



1. "HORIZ CENTERING" knob
2. "VIDEO OUT" receptacle
3. "VERT CENTERING" knob
4. Cathode Ray Tube Screen
5. "SPECTRUM CALIBRATOR" - "AMPLITUDE" knob
6. "SPECTRUM CALIBRATOR" - "FREQUENCY" knob
7. "FOCUS" knob
8. "BRIGHTNESS" knob
9. "SPECTRUM CENTERING" - "COARSE" knob
10. "SPECTRUM CENTERING" - "FINE" knob
11. "POWER" switch
12. "3 AMP" fuse
13. "3 AMP" fuse
14. "POWER" indicator lamp
15. "METER SELECTOR" switch
16. Voltmeter indicator
17. "SCALE ILLUMINATION" knob
18. "SPARES" (fuses)
19. "INTENSIFIER" knob
20. "SYNC" knob
21. "SPECTRUM WIDTH" knob
22. "SWEEP FREQ" knob
23. "VERT GAIN" knob
24. "HORIZ GAIN" knob
25. "2ND I-F GAIN" knob
26. "EXT SYNC" receptacle
27. "LIN" "LOG" or "SQ" det. switch
28. Panel screws

Figure 2-1. Analyzer Indicator, Front Panel View



1. "10-150 MCS" input receptacle
2. "150-350 MCS" input receptacle
3. "350-1000 MCS" input receptacle
4. "1000-16,000 MCS" input receptacle
5. "FREQUENCY IN MEGACYCLES" dial
6. "I-F ATTENUATION - DB" knob
7. "TUNE" knob
8. "BAND SELECTOR" knob
9. Panel screw

Figure 2-2. R-F Tuner, Front Panel View

2-14. Rotate the "BAND SELECTOR" knob (8, figure 2-2) to the desired frequency range.

2-15. Rotate the "TUNE" knob (7, figure 2-2) to the desired frequency (until signal appears on the scope). For an example of a rectangular pulse viewed on scope screen see figure 2-7.

2-16. Rotate the "I-F ATTENUATION DB" knob (6, figure 2-2) to the desired pulse amplitude on the scope. Set the "VERT GAIN" (23, figure 2-1) to the desired height and note the "VERT GAIN" setting. It is preferable to keep this control close to full clockwise rotation but never below 1-1/2 divisions. See figure 2-8 for appearance of r-f pulse after attenuation and vertical gain adjustments have been made.

NOTE

Use the "SPECTRUM WIDTH" control during frequency analysis whenever it is desired to calibrate the width of the scope reticle to represent a bandwidth from 1/2 to 25 mc. Refer to Table IV for the function of this control.

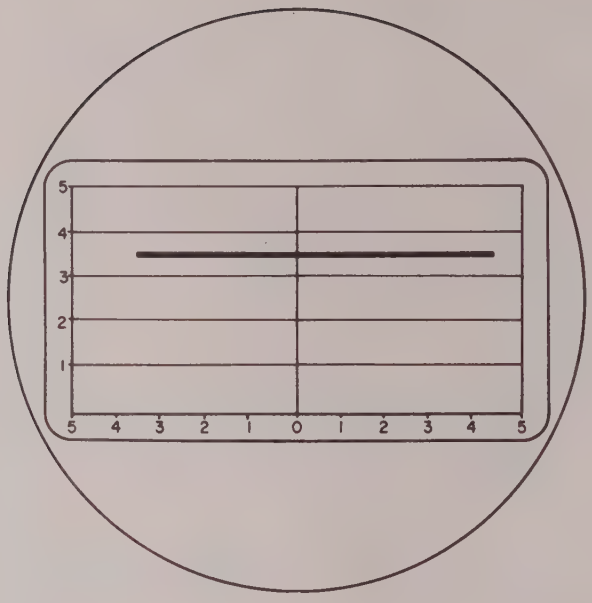


Figure 2-3. Line Trace on CRT with Proper Brightness

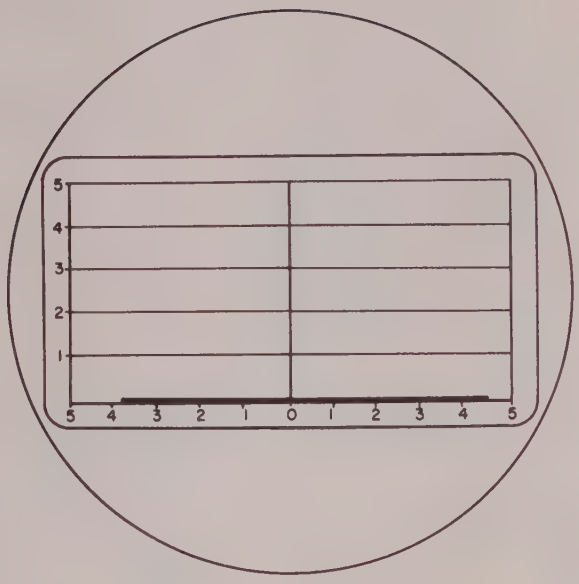


Figure 2-4. Line Trace on CRT with Proper Centering

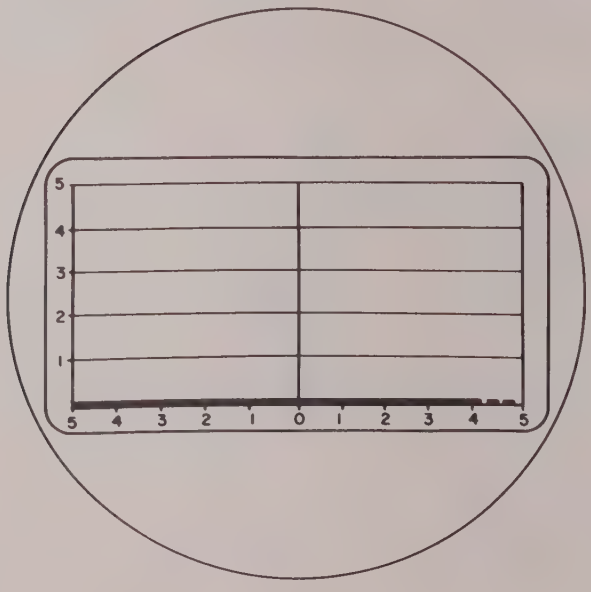


Figure 2-5. Line Trace on CRT with Proper Horizontal Gain

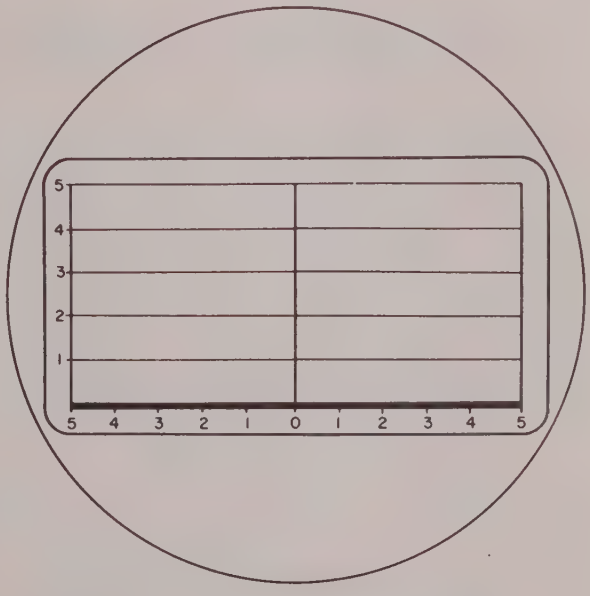


Figure 2-6. Line Trace on CRT with Proper Synchronization

2-17. Turn the "VERT GAIN" (23, figure 2-1) down to "O". Adjust the "BRIGHTNESS" (8) control until the base line just disappears. Return the "VERT GAIN" to the position set in paragraph 2-16. Adjust the "INTENSIFIER" potentiometer (19, figure 2-1) clockwise until the vertical signals are visible to a desired intensity. See figure 2-9 for a typical view obtained under such conditions. The image will consist solely of vertical lines of various heights. The intensity of the curve bounding the vertical lines is exaggerated.

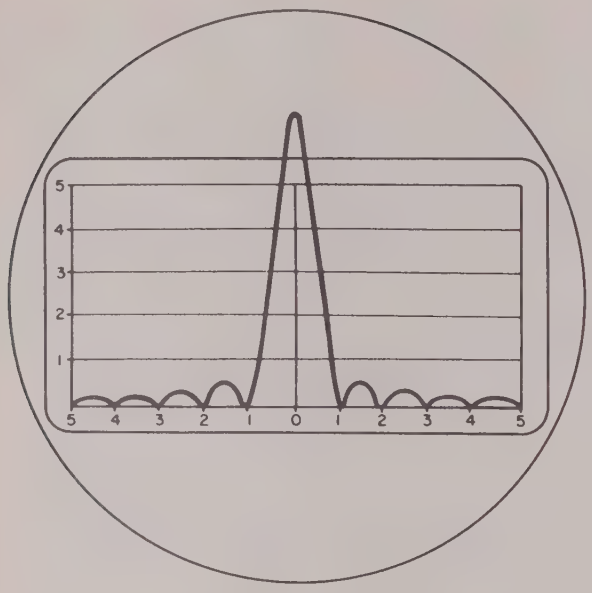


Figure 2-7. Typical R-F Pulse on CRT before Vertical Gain and I-F Attenuation Adjustments

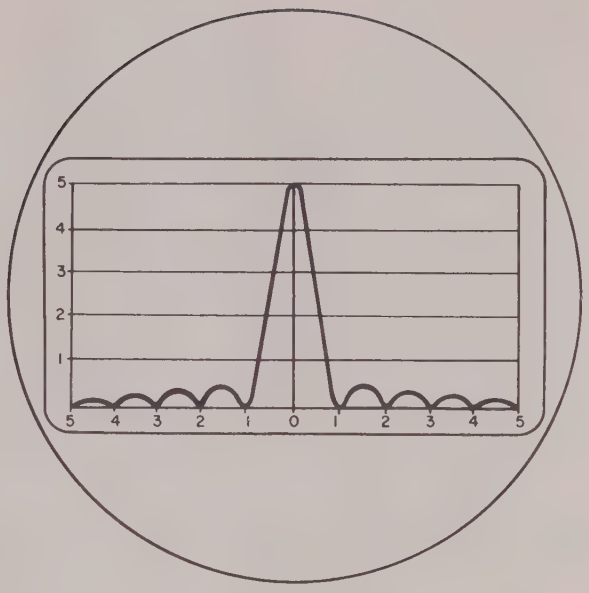


Figure 2-8. Typical R-F Pulse on CRT after Vertical Gain and I-F Attenuation Adjustments

2-18. TESTS PERFORMED WITH THE SPECTRUM ANALYZER.

2-19. The basic tests made on radar transmitters or other equipment with the spectrum analyzer are conveniently tabulated in table V. The table indicates the type of test which can be made, along with special instructions on the procedure to follow when performing each test. A typical CRT pattern encountered for each test is illustrated and remarks are given on the analysis and interpretation of the pattern observed. The analyzer can be used to check the spectrum of a magnetron or a pulsed test oscillator, the frequency stability of kylstrons and magnetrons, the bandwidth and pulse width of r-f oscillators, the modulated output of magnetrons to find that no excessive frequency modulation exists, and for other purposes.

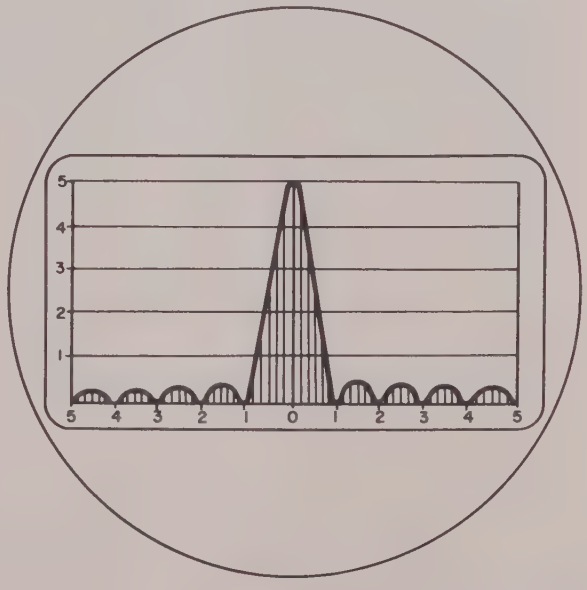


Figure 2-9. R-F Pulse Properly Adjusted

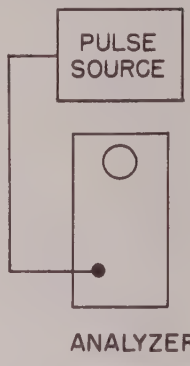
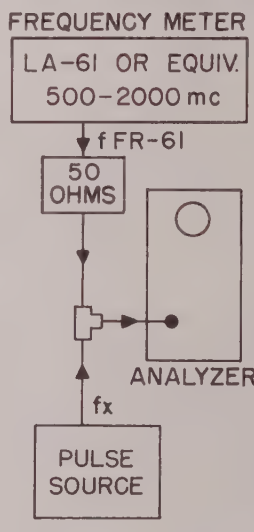
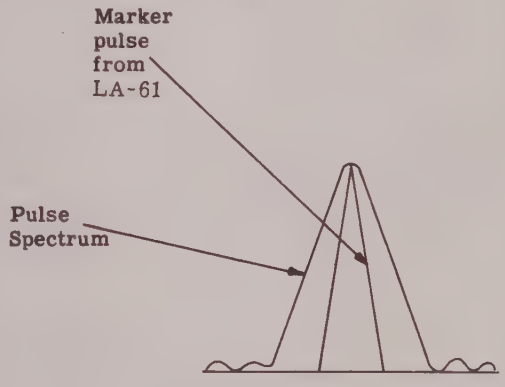
2-20. ANALYSIS OF VARIOUS SCOPE PRESENTATIONS.

2-21. Various scope patterns may be encountered while checking the spectra of radar transmitters. The spectrum patterns most commonly encountered may signify proper or improper operation. Examples of proper and improper spectra are illustrated in figures 2-10 through figures 2-17 and an analysis of each pattern is given in the following paragraphs.

2-22. Shown in figure 2-10 is a spectrum of a rectangular pulse with neither amplitude nor frequency modulation during the pulse. The form of the spectrum is obviously symmetrical. Minima in the spectrum occur at ± 1 mc/sec, ± 2 mc/sec, ± 3 mc/sec, and so forth. This is representative of the spectrum of a properly operating magnetron or of a good pulsed oscillator.

2-23. Figure 2-11 illustrates the spectrum of a symmetrical trapezoidal voltage pulse with no frequency modulation. The pulse is one microsecond wide at the base and 0.6 microseconds wide at the top. The pulse

TABLE V. EXAMPLES OF ANALYZER USES

TYPE OF TEST	SET UP	PROCEDURE	SCOPE PATTERN	INTERPRETATION
Checking frequency stability of klystrons and magnetrons		Follow steps 2-6 through 2-17. Set "SPECTRUM CALIBRATOR" by adjusting the "AMPLITUDE" and "FREQUENCY" control until a single frequency cw signal appears on the scope. Allow signal to stand for a few minutes to check for drift.	 Single frequency cw pip or marker signal	Single frequency cw pip or marker present. If the signal on the screen does not drift, with respect to Spectrum Calibrator marker, frequency stability is proper. Any occurring drift is a sign of non-stable operation.
Method for measuring frequencies higher than 500 mc within 0.001% using the FR-61 frequency meter.		1. Obtain f_X on screen. 2. Determine exact f_{LO} of the spectrum analyzer via the frequency meter LA-61 3. Set the LA-61 frequency meter 160 mc higher than the f_{LO} determined in step 2. 4. Zero beat the marker signal with frequency (f_X) signal. 5. Read the exact frequency on the LA-61 frequency meter. This frequency is f_{LA-61} 6. Obtain the difference frequency f_d as follows: $f_d = f_{LA-61} - f_{LO}$ 7. Obtain the unknown frequency f_X as follows: $f_X = H(f_{LO}) + f_d$		

is shorter than a one microsecond rectangular pulse and, accordingly, the first minima occur at frequencies which differ by slightly more than two mc/sec. The most notable difference between the shape of this spectrum and that revealed in figure 2-10 is the reduction of amplitude of the side lobes relative to the center lobe.

2-24. Revealed in figure 2-12 is the spectrum of a symmetrical triangular voltage pulse with no frequency modulation. Since the pulse is one microsecond wide at the base and triangular, the pulse is shorter than a one-microsecond rectangular pulse. Accordingly, the first minima are at frequencies differing by more than two mc/sec. The minima occur at ± 2 mc/sec, ± 4 mc/sec, and so forth. The side lobes are practically negligible.

TABLE V. EXAMPLES OF ANALYZER USES (cont)

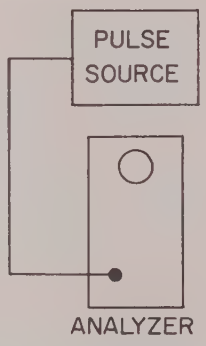
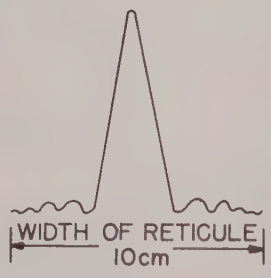
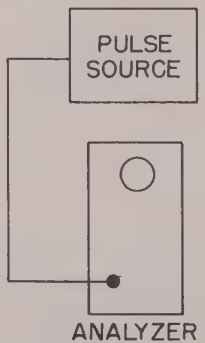
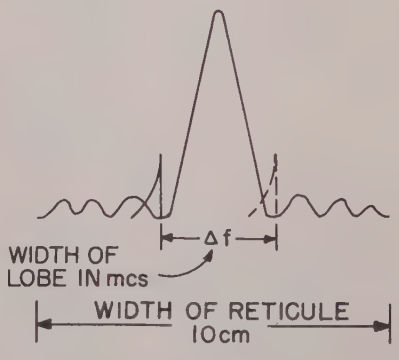
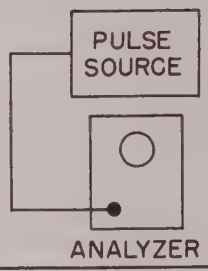
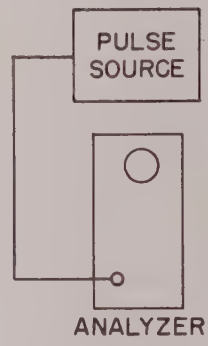
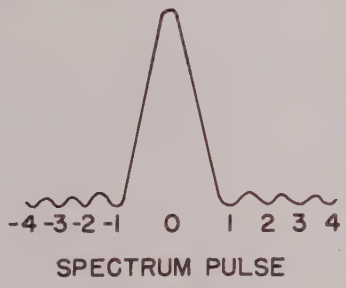
TYPE OF TEST	SETUP	PROCEDURE	SCOPE PATTERN	INTERPRETATION
		SYMBOL DESIGNATION:		
		f_x = Unknown frequency to be measured.		f_{LO} = local oscillator frequency of spectrum analyzer.
		f_d = difference frequency.		f_{FR-61} = frequency of FR-61 where marker signal is zero beating with f_x on LA-61.
		H = harmonic of the spectrum analyzer local oscillator		
Checking bandwidth of r-f oscillators		Follow steps 2-6 through 2-17. Use "SPECTRUM WIDTH" control for calibrating the 10-cm reticule width to represent a bandwidth suitable for measureing the width of the pulse.		10 cm corresponds to the quantitative figure in "MCS" to which the "SPECTRUM WIDTH" control is positioned. The centimeter width of the pulse represents a corresponding value in megacycles. Ex: If 10 cm = 20 mc, 5 cm = 10 mc 1 cm = 2 mc
Checking pulse width of r-f oscillator		Follow steps 2-6 through 2-17. Use single frequency cw pip or marker to measure the width of the main lobe with aid of reticule division. Use "SPECTRUM WIDTH" control for calibrating the 10-cm reticule width to represent a bandwidth suitable for measuring the width of the main lobe of the pulse. Adjustment of "SPECTRUM CALIBRATOR" produces marker on scope screen.		Pulse width is equal to $\frac{2.}{\Delta}$

TABLE V. EXAMPLES OF ANALYZER USES (cont)

TYPE OF TEST	SETUP	PROCEDURE	SCOPE PATTERN	INTERPRETATION
Check modulated output of magnetrons		Follow steps 2-6 through 2-17.		Flat frequency modulation. Pattern signifies modulated output of magnetron is proper. If current pulse is not flat excessive frequency modulation exists.
Checking the spectrum of a magnetron or a pulsed test oscillator		Follow steps 2-6 through 2-17.		Spectrum of a rectangular pulse with neither amplitude nor frequency modulation during the pulse. The pulse is symmetrical. Minima in the spectrum occur at ±1 mc/Sec, ±2 mc/sec, etc. Therefore, the pulse shown is representative of a properly operating magnetron or a good pulsed test oscillator.

2-25. Illustrated in figure 2-13 is an error-function voltage pulse with no frequency modulation. A transient of this type is unique in that the spectrum has the same form as the transient. The spectrum has no side lobes although it extends to plus or minus infinity. The portion of the spectrum beyond $f - f_o \pm 1\text{-}5$ mc/sec is negligible. The pulse shown is one having a spectrum of the same amplitude and half-power width as the one-microsecond rectangular pulse shown by the dashed lines. The shape of the center region of the spectrum is almost identical with that of the rectangular pulse spectrum illustrated in figure 2-10.

2-26. Shown in figure 2-14, a, b and c are rectangular pulses with no amplitude modulation during the pulse, but with varying amounts of linear frequency modulation. The first effect of increasing the frequency modulation is to raise the minima which no longer are located at zero, as indicated by the spectrum of figure 2-14a. Such action signifies that less energy is present in the center lobe. As the modulation increases, the secondary maxima rises until the center is reached, forming two peaks rather than one. This is shown by the spectrum of

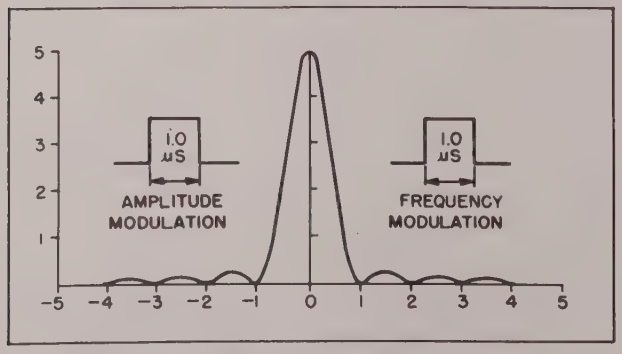


Figure 2-10. Rectangular Pulse with Neither Amplitude nor Frequency Modulation during the Pulse

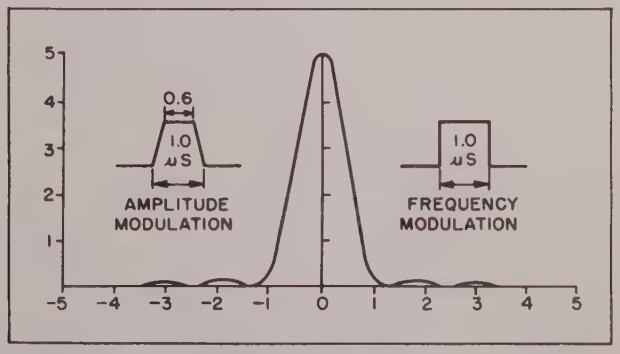


Figure 2-11. Symmetrical Trapezoidal Voltage Pulse with no Frequency Modulation

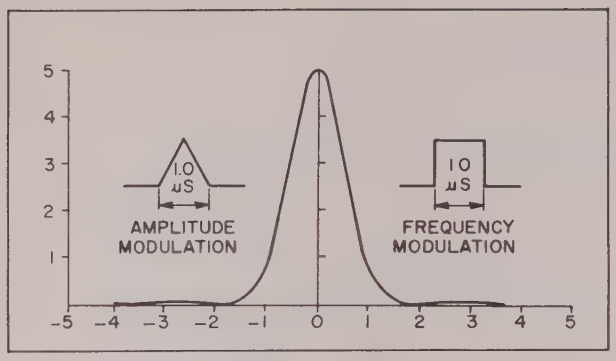


Figure 2-12. Symmetrical Triangular Voltage Pulse with no Frequency Modulation

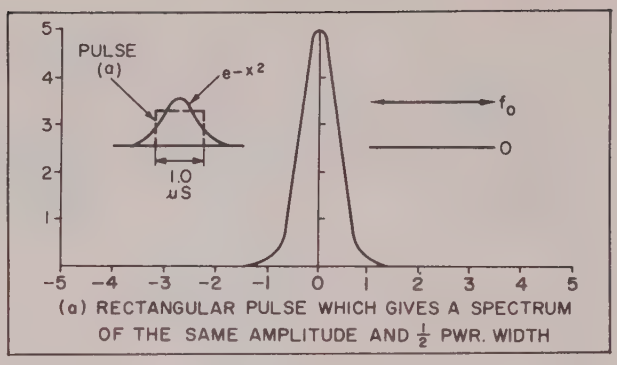


Figure 2-13. Error-Function Voltage Pulse with no Frequency Modulation

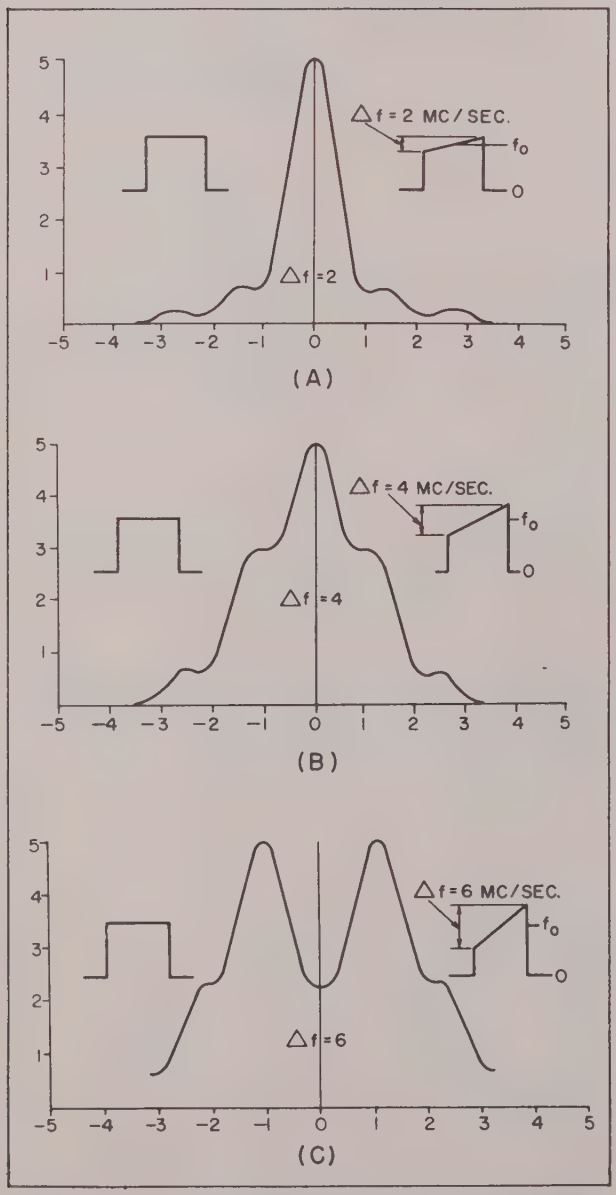


Figure 2-14. Rectangular Pulse with no Amplitude Modulation during the Pulse-Varying Amounts of Linear Frequency Modulation Present

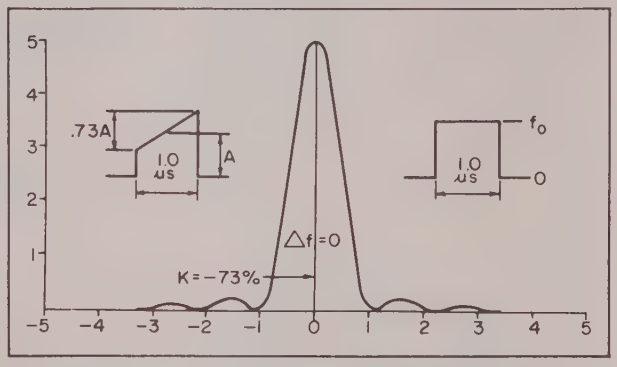


Figure 2-15. Linearly Sloped Pulse - 73 percent Amplitude Modulation with no Frequency Modulation

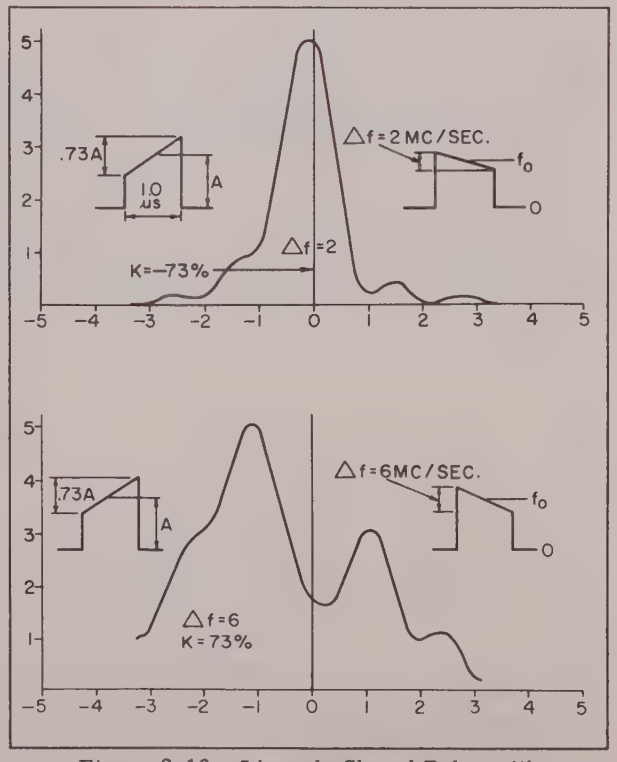


Figure 2-16. Linearly Sloped Pulse with Linear Frequency Modulation

figure 2-14b. With higher modulation, more peaks can be formed as shown in figure 2-14c with the result that very little energy is located in the central region. All spectra in figure 2-14 are symmetrical and would be unchanged if the frequency modulation were reversed in polarity. Spectrum of figure 2-14a is classed as good, that of figure 2-14b is classed as fair and that of figure 2-14c is classed as poor.

2-27. Figure 2-15 illustrates a linearly sloping pulse with amplitude modulation of 73 percent and no frequency modulation. This spectrum is very similar to that of the rectangular pulse shown in figure 2-10. The only difference is that the minima are not quite zero. The shape of the spectrum is not greatly altered even when the modulation is 200 percent (sawtooth form). Since there is no frequency modulation the spectrum is symmetrical. If the slope of the pulse were reversed the spectrum would be unchanged.

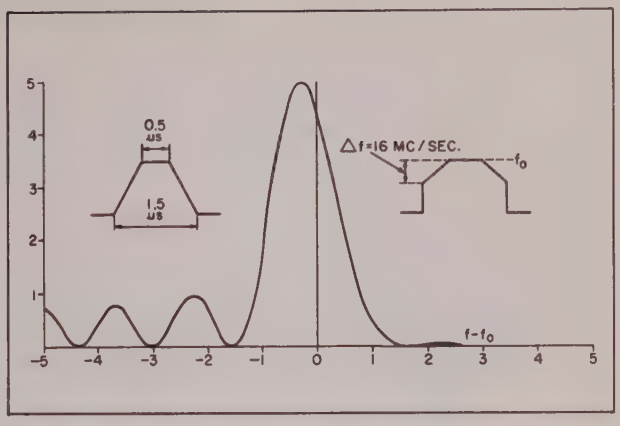


Figure 2-17. Trapezoidal Pulse with Trapezoidal Frequency Modulation

2-28. Figure 2-16 indicates a linearly sloping pulse linearly frequency modulated. In the case of linear frequency modulation with no amplitude modulation the spectrum was symmetrical (see figure 2-14). In figure 2-16 the pulses are not symmetrical and the frequencies at which the pulse was higher amplitude are preferred to those frequencies at which the amplitude is low. The frequency is lowest where the amplitude is highest with the result that the spectrum is pushed in the direction of lower frequency.

2-29. Displayed in figure 2-17 is a trapezoidal pulse, trapezoidally frequency modulated. A large part of the pulse is rectangular so that a main lobe resembling that of a rectangular pulse is obtained. This is a form of spectrum which is commonly encountered from magnetrons and low-power pulsed oscillators. The almost complete absence of side lobes on one side and side lobes larger than usual on the other is typical. The frequency modulation causes a shift of the spectrum in the low-frequency direction but the effect is not as pronounced as it would be if the amplitude were unmodulated. The effective width of the pulse is between 0. 5 and one microsecond as indicated by the position of the zeros.

2-30. From the spectra illustrated in figures 2-10, 2-11, 2-12, 2-13 and 2-15, observe that each of the spectra are symmetrical. Generally, in the absence of frequency modulation any r-f pulse will produce a symmetrical spectrum. When the frequency modulation is zero, changing the shape of the amplitude modulation, while keeping the effective pulse width constant, alters the relative sideband amplitudes but has little effect on the main lobe. The spectra in figures 2-10, 2-12, 2-13 and 2-15 reveal this fact. From the spectra illustrated in figure 2-14 observe that in the case of no amplitude modulation a linear frequency modulation will result in a symmetrical spectrum. In general, with no amplitude modulation, a frequency modulation that is an odd function about the center of the pulse will produce a symmetrical spectrum. In fact, frequency modulation has the effect of broadening the spectrum and is usually more serious than amplitude modulation.

2-31. Use of Crystal Mixers. (350-1000 mc and 1000-16 Kmc ranges)

CAUTION

Input signals to crystals must never exceed 5 milliwatts or damage to crystals may result. Always keep signal level as low as possible.

SERVICE EQUIPMENT REQUIREMENTS

R. F. SIGNAL GENERATORS:

Range in Megacycles	Instrument
10-500	Hewlett Packard 608C or equivalent
450-1200	H. P. 612A; Lavoie TS-418 or equivalent
800-2100	H. P. 614A; Lavoie TS-419 or equivalent
1800-4000	Hewlett Packard 616A or equivalent
3800-7600	Hewlett Packard 618B or equivalent
7000-11000	Hewlett Packard 620A or equivalent
10000-16000	Hewlett Packard 626A or equivalent
	Hewlett Packard 628A or equivalent

PULSE GENERATOR:

Lavoie 593 or equivalent

AUDIO SIG. GENERATOR:

Hewlett Packard 200C or equivalent

FREQUENCY METERS:

Range in Megacycles	Instrument
10-100	Lavoie LA-5; FR-5; URM80 or equivalent
100-500	Lavoie LA-6; FR-6; URM81 or equivalent
500-2000	Lavoie LA-61; FR-61 or equivalent

VOLTMETERS:

Ballantine 300 or Dayen 170A or equivalent

Simpson 260 or Triplet 630 or equivalent

AN/SPM-3 Voltmeter or equivalent

1 Variac

SECTION III

OPERATING CHECKS AND ADJUSTMENTS

3-1. GENERAL.

3-2. This section contains information on equipment operating checks and adjustments which are considered necessary and which may be made by the operator prior to or during actual operation. Following the instructions given in this section will insure the operator that the equipment has been properly adjusted for use. The checks and adjustments to be made primarily require simple alignment of screwdriver-adjustment potentiometers. If the analyzer fails to function properly after the alignment procedures in this section are followed the operator should refer the trouble to maintenance personnel.

3-3. OPERATING CHECKS AND ADJUSTMENTS (with Indicator and Tuner Drawers electrically connected.)

3-4. PLATE VOLTAGE SUPPLY. To check and adjust the plate voltage supply in the indicator unit (figure 2-1) follow the procedures given below:

a. Plug the power cord into an external supply of 115 volts, 50 to 400 cps, ac.

b. Throw on the "POWER" switch (11, figure 2-1). Observe the "POWER" indicator lamp (14). It must light.

c. Rotate the "METER SELECTOR" knob (15, figure 2-1) to "LINE VOLTS". Observe the indicated voltage reading on the voltmeter (16). It must read approximately 115 volts. (Refer to paragraph 6-3c. through 6-3k.)

NOTE

Remove 8 shipping bolts at rear of cabinet in order to slide out drawers.

d. Rotate the "METER SELECTOR" knob (15, figure 2-1) to "+150V". Observe the indicated voltage reading on the voltmeter (16). Voltmeter must read 150 volts ±1 volt. If the reading varies substantially from this value, follow the instructions given in steps f and g in paragraph 3-4 for an additional check and necessary adjustments to be made.

e. Rotate the "METER SELECTOR" knob to "-150V". Observe the indicated voltage reading on the voltmeter. Voltmeter (16) must read 150 volts ± 1 volt. If the reading varies substantially from this value, follow the instructions given in steps f and g in paragraph 3-4 for an additional check and necessary adjustments to be made.

f. Loosen the 15 panel screws (28, figure 2-1) on the indicator unit and slide the drawer forward. (Refer to paragraph 5-1f.) Remove the top cover to gain access to the top of the power supply chassis (figure 3-1). Place the positive test lead of a suitable voltmeter into the +150-volt jack, TP1301, colored red, on top of the power supply chassis. Place the negative test lead of the voltmeter to chassis ground. Observe the voltmeter reading. If the reading varies considerably from 150 volts, potentiometer R1381 requires adjustment. Refer to paragraph 3-4g for adjustment procedure. Place the negative test lead of the voltmeter into the -150-volt jack, TP1302, colored white, and the positive test lead to chassis ground. Observe the voltmeter reading. If the reading varies considerably from 150 volts, potentiometer R1371 requires adjustment. Refer to paragraph 3-4g, for adjustment procedure.

g. Remove the voltmeter from the test jacks. With the "METER SELECTOR" switch (15, figure 2-1) on "+150V" adjust potentiometer R1381 (figure 3-1) with a screwdriver until the voltmeter on the indicator unit panel reads 150 volts. With the "METER SELECTOR" switch on "-150 V", adjust potentiometer R1371 with a screwdriver until the voltmeter (16, figure 2-1) reads 150 volts. Adjust R1701 for 91 volts across primary of T1301.

h. Replace and secure the top cover of the indicator drawer. Slide the drawer into the instrument case and tighten all panel screws.

3-5. SPECTRUM CENTERING. The adjustment to be made for spectrum centering is performed only when the operator has determined that the "SPECTRUM CENTERING" controls (9, 10, figure 2-1) cannot properly center the desired spectra viewed on the scope screen. To correct for spectrum centering perform the procedures as follows:

a. Loosen the 15 panel screws (shown in figure 2-1) on the indicator drawer and slide the drawer forward (refer to paragraph 5-1f).

b. Set the "COARSE" and "FINE" controls ("SPECTRUM CENTERING") to their zero position. Adjust potentiometer R1016 ("CENTERING ADJUST"), with a screwdriver until the centering is restored on the scope screen. Allow setting to remain.

c. Carefully slide the drawer into the instrument case and secure all indicator panel screws.

3-6. SPECTRUM WIDTH. The adjustment to be made for spectrum width is performed only when the operator has encountered difficulty in obtaining the full 25-megacycle sweep by using the "SPECTRUM WIDTH" control (21, figure 2-1). The full range of the "SPECTRUM WIDTH" control is restored by performing the procedures as follows:

a. Loosen the 15 panel screws on the indicator drawer and slide the drawer forward (refer to paragraph 5-1f). Remove the top cover of the drawer to gain access to the power supply chassis (figure 3-1).

b. Adjust potentiometer R1341 (figure 3-1) with a screwdriver until the full range of the 25-megacycle sweep is restored on the scope screen. The "SPECTRUM WIDTH" control (21, figure 2-1) must be positioned to "25" during the adjustment procedure.

c. Replace and secure the top cover of the indicator drawer. Slide the drawer into the instrument case carefully and tighten all panel screws.

TABLE VI. LIST OF CRYSTAL DIODES

Crystal Type	Manufacturer
IN23B	
LA26	Lavoie
IN26B	
LA78	Lavoie
IN78	
IN126	
IN625	
CBS IN82AG	CBS

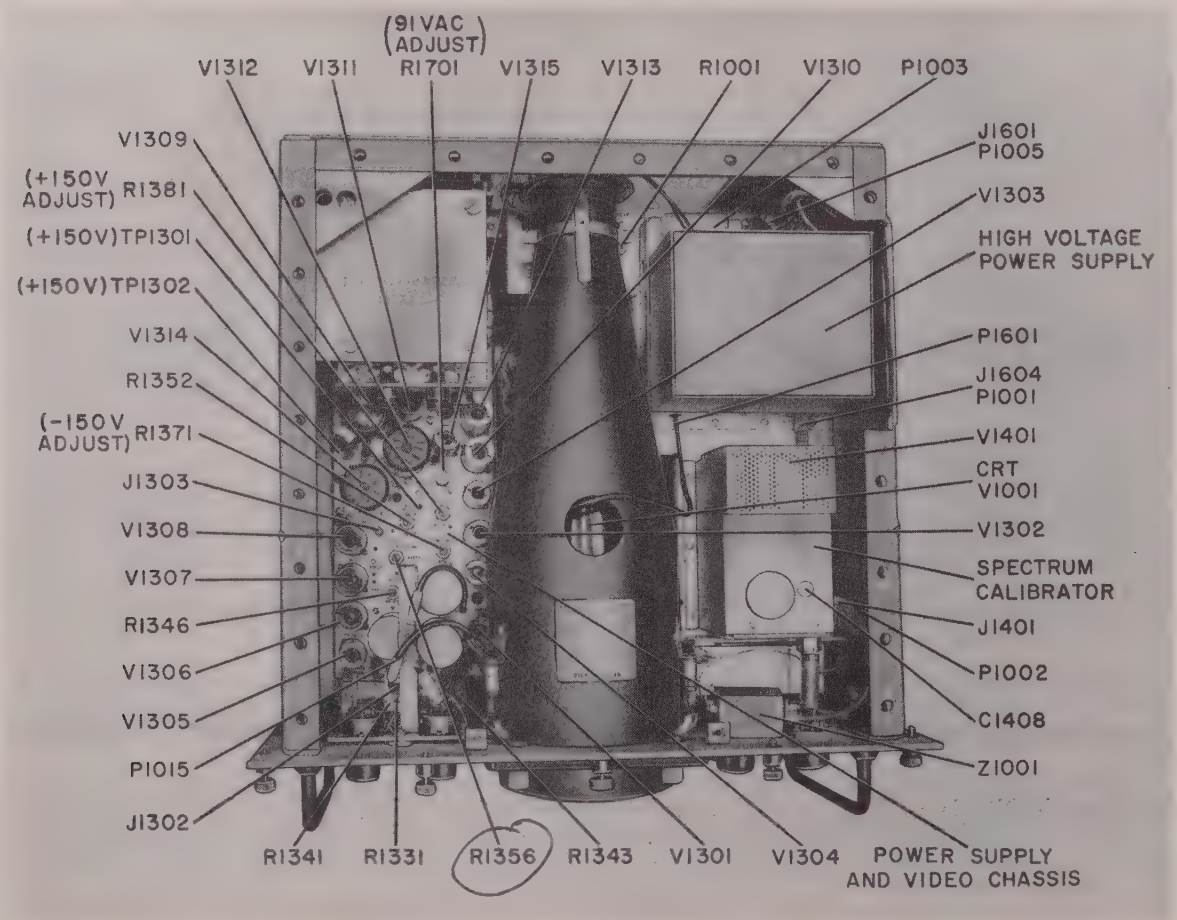


Figure 3-1. Analyzer Indicator, Top View

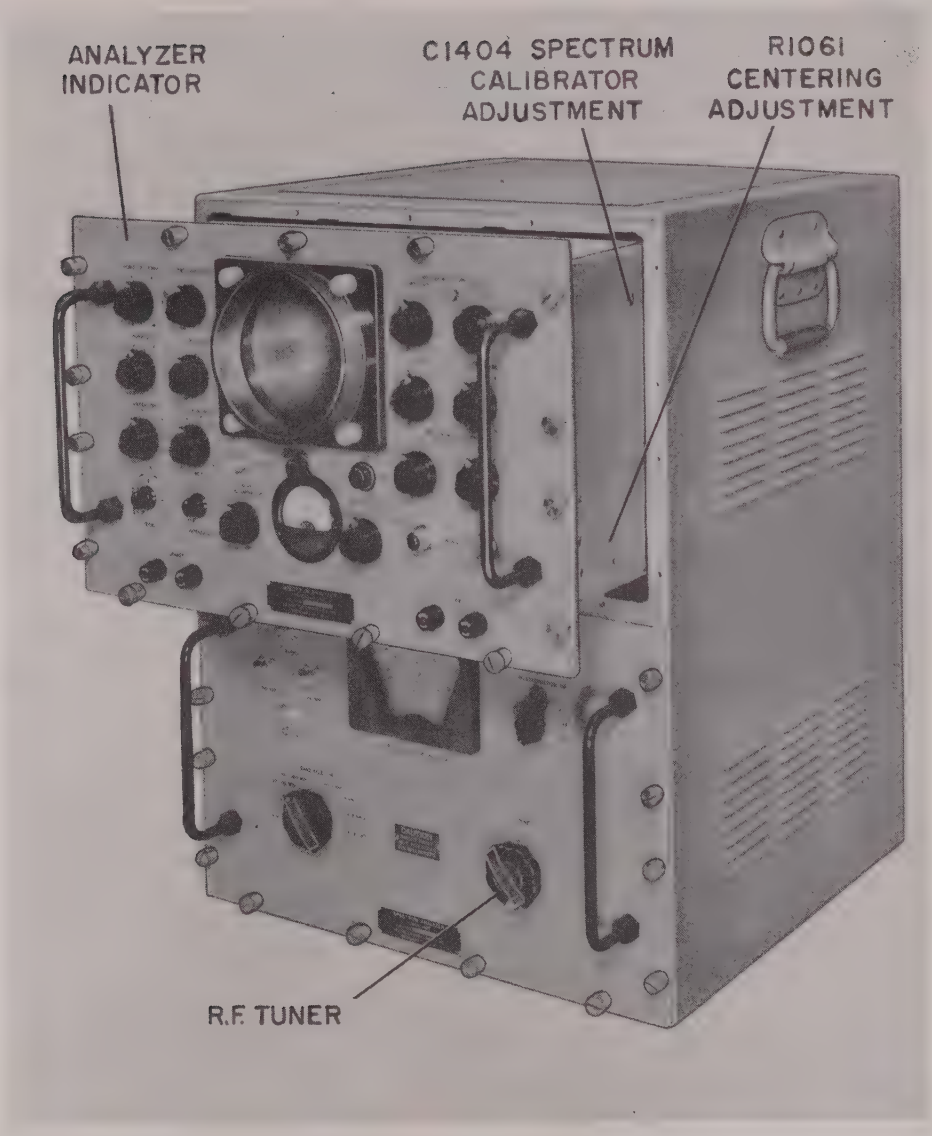


Figure 3-2. Spectrum Analyzer LA-18A, Right Side

TABLE VII. TUBE COMPLEMENT

COMPONENT	TUBE		FUNCTION	QUANTITY
	JAN. NO.	REFERENCE SYMBOL		
1 MC I-F Amplifier	6AU6WA	V1205	Square Law Amplifier	2
		V1206	Square Law Amplifier	
	5725/6AS6W	V1202	Mixer	1
	1/2 12AT7WA	V1201	Oscillator	2
	1/2 12AT7WA		Frequency Doubler	
	12AT7WA	V1204	Phase Inverter	
	6186/6AG5WA	V1203	Amplifier	1

TABLE VII. TUBE COMPLEMENT (cont)

COMPONENT	TUBE		FUNCTION	QUANTITY
	JAN. NO.	REFERENCE SYMBOL		
64 MC I-F Amplifier	6AN4	V1101	Mixer	1
	5654/6AK5WA	V1102	I-F Amplifier	4
		V1103	I-F Amplifier	
		V1104	I-F Amplifier	
		V1105	I-F Amplifier	
160 MC I-F Amplifier	5654/6AK5WA	V2201	I-F Amplifier (Wideband)	10
		V2202	I-F Amplifier (Wideband)	
		V2203	I-F Amplifier (Wideband)	
		V2204	I-F Amplifier (Wideband)	
		V2205	I-F Amplifier (Wideband)	
		V2206	I-F Amplifier (Wideband)	
		V2207	I-F Amplifier (Wideband)	
		V2208	I-F Amplifier (Narrowband)	
		V2209	I-F Amplifier (Narrowband)	
		V2210	I-F Amplifier (Narrowband)	
Sweep Frequency Generator	5654/6AK5WA	V1501	Reactance Modulator	3
		V1505	Frequency Tripler	
		V1506	Frequency Doubler	
	6AH6	V1503	R-F Amplifier	2
		V1504	R-F Amplifier	
	12AT7WA	V1502	Frequency Modulated Osc.	1
Oscillator 1 and 2	6AN4	V2501	Oscillator	4
		V2502	Mixer	
		V2503	Oscillator	
		V2504	Mixer	
Oscillator 3	5675	V2301	Oscillator	1
		CR2301	Mixer (Crystal)	
Oscillator 4	5675 (Modified)	V2401	Oscillator	1
		CR2401	Mixer (Crystal)	
Power Supply and Video	1/2 12AT7WA	V1301	Cathode Follower	1
	1/2 12AT7WA		Phase Inverter	
	12AX7	V1308	Horizontal Amplifier	3
	12AX7	V1310	Volt. Reg. Amplifier	
	12AX7	V1313	Volt. Reg. Amplifier	
	1/2 5814A	V1306	Cathode Follower	2
	1/2 5814A		Cathode Follower	
	1/2 5814A	V1307	Cathode Follower	
	1/2 5814A		Cathode Follower	
	6AU6WA	V1302	Video Amplifier	3
	6AU6WA	V1303	Video Amplifier	
	6AU6WA	V1304	Intensifier Squaring	
	5725/6 AS6W	V1305	Sawtooth Generator	1
	6AH6	V1315	Error Voltage Amplifier	1
	6080	V1309	Series Regulator	1

TABLE VII. TUBE COMPLEMENT (cont)

COMPONENT	TUBE		FUNCTION	QUANTITY
	JAN. NO.	REFERENCE SYMBOL		
	5651	V1311	Reference Voltage Regulator	1
	6CA7 or 6L6GB	V1312	A. C. Line Regulation	2
	6CA7 or 6L6GB	V1314	A. C. Line Regulation	
Spectrum Calibrator	12AT7WA	V1401	Oscillator	1
Analyzer Indicator	5ADP7	V1001	Cathode-Ray Tube (Display)	1

TABLE VIII. FUSE COMPLEMENT

COMPONENT	FUSE	RATING	TYPE NO.
Analyzer Indicator	F1001	3	3A-G
	F1002	3	3A-G
Power Supply	F1301	1	3A-G
	F1302	.25	3A-G

SECTION IV

THEORY OF OPERATION

4-1. GENERAL.

4-2. This section contains a discussion on the theory of operation of the spectrum analyzer. The theory is described primarily for maintenance technicians equipped with experience on similar or related equipment. The description given in this handbook covers a treatment of circuitry operation characteristic to the particular equipment. With the aid of a functional block diagram, a description of circuit operation is given in the order of signal sequence. A detailed circuit analysis of each component is included and references are made to electrical schematics.

4-3. FUNCTIONAL OPERATION OF THE ANALYZER.

4-4. Shown in figure 7-1 is a functional block diagram of the spectrum analyzer, indicating a signal flow. The spectrum analyzer is physically divided into two major components: the Analyzer Indicator and the R-F Tuner. The Analyzer Indicator is actually a complete spectrum analyzer which covers a limited frequency range from 147.5 to 172.5 megacycles. The R-F Tuner is primarily a frequency converter which changes the frequency range of 10 to 16,000 megacycles of the LA-18A into the basic frequency range of 147.5 to 172.5 megacycles required by the Pulse Indicator. The converted signal from the tuner unit is fed to the indicator unit where the time signal is changed to a frequency domain signal. This latter signal is that which is viewed on the CRT screen on the panel of the indicator unit. The CRT pattern produced is a plot indicating power or voltage vertically and frequency horizontally.

4-5. The incoming r-f signal may enter one of the four input receptacles on the tuner-drawer panel to accommodate the range of r-f frequencies to be analyzed. Each incoming signal is fed to one of four mixers (V2504, V2502 in oscillator 1 and 2, or the crystals of oscillator 3 and oscillator 4). A local oscillator (V-2503, V-2501, V2301, or V2401) generates a signal to beat against the incoming r-f signal in one of the mixers. The frequency of the local oscillator is made variable by manual use of the "TUNE" control on the panel of the tuner drawer. When the difference between the local oscillator frequency and the incoming r-f frequency is equal to the i-f frequency (160 mc), a signal is produced at the output of the 1st mixer which is proportional to the amplitude of the r-f signal. The mixer signal (the difference frequency, 160 mc) is then fed to the 160 mc i-f amplifier through the band selector switch S2202. This switch enables selection of one of the four mixer output signals, feeding it to either the wideband (25 mc) or the narrowband (5 mc) i-f amplifier.

Operation With Input Signals Below 50 Mc

When the input signal to the Spectrum Analyzer is below 50 mc, the following dial settings should be maintained:

Function	Setting
Band Selector	10-150 mc - Narrow
Spectrum Centering	Coarse 0 - Fine 0. Off centering to be kept to a minimum
Spectrum Width	5 mc
Spectrum Calibrator	To be used between ± 2.5 mc

Input signals below 10 mc may be displayed on the Spectrum Analyzer down to 3 mc provided the Spectrum width dial is set to half the input freq. in megacycles. All other controls should be set as indicated above.

When the input signal to the Spectrum Analyzer is between 147 and 172 mc, this constitutes the Analyzer being required to tune through its own 1st IF. When this is done, it will be noted that two signals will appear (Spectrum centering controls should both be on 0 at this time). One where the input signal feeds straight through the 1st mixer and through the 1st IF. The second signal will be the result of the input signal beating with the local oscillator. The second signal will appear coincident with the first signal when the dial reading corresponds with the frequency of the input signal plus or minus its deviation from 160 mc.

4-6. The 160 megacycle I-F amplifier is used to perform the following functions: a) to wideband amplify the signal before the time-domain, frequency-domain conversion; b) to provide isolation between the first mixer and the mixer V1101 to the 64-megacycle I-F amplifier strip (possessing sawtooth signal), thereby preventing sawtooth or frequency modulated signals from being present at the input receptacles on the tuner-drawer panel; c) to introduce the spectrum calibrator into the system.

4-7. The output of the I-F amplifier can be attenuated from zero to 60 db in 6 db steps by manual control of the "I-F ATTENUATOR" switch S2002 on the front panel of the R-F Tuner-drawer. A signal from a frequency marker oscillator (spectrum calibrator) also feeds into the 160-megacycle amplifier. The spectrum calibrator contains a tunable high frequency oscillator which produces a marker pip, adjustable in amplitude and frequency, on the CRT screen. The marker pip permits frequency measurements of the CRT pattern to be conveniently made.

4-8. The output signal of the 160-megacycle I-F amplifier is then fed from the tuner drawer to the indicator drawer where it is introduced into a mixer and the 64-megacycle I-F amplifier together with the output of the sweep frequency generator. The 64-megacycle I-F amplifier contains a second mixer which converts the 160-megacycle input to a lower frequency of 64 megacycles. The output of the sweep frequency generator is centered about 224 megacycles and is frequency swept by means of a sawtooth voltage. The frequency deviation is plus and minus 1/4 megacycle, minimum, to plus and minus 12-1/2 megacycles, maximum. In addition, the center frequency may be varied plus and minus 15 megacycles about the mean of 224 megacycles. The result is a series of 64-megacycle signals all occurring at different sequential times. These signals are then fed to the V1202 mixer in the one-megacycle I-F amplifier.

4-9. In the one-megacycle I-F amplifier a local crystal oscillator Y1201 generates a frequency of 32.5 megacycles which is fed to a frequency doubler V1201. The doubler doubles the 32.5-megacycle signal to produce an output of 65 megacycles which is fed to the input of mixer V1202. Mixer V1202 mixes the 65-megacycle signal and the 64 megacycle input signal to produce a difference frequency of one megacycle. The one-megacycle signal is then amplified by amplifier V1203, inverted by phase inverter V1204, and fed to a square law amplifier V1205, followed by a detector, V1206. The square law amplifier operates at a small signal level to produce an output voltage which is square law. A linear signal is obtained from V-1204, which feeds a linear and a log detector. Switch S1005 (26, figure 2-1) provides selection of one of these detectors. The output of the detector switch is then fed to the video circuitry in the power supply and video unit. This unit contains sawtooth generating circuits, performing the dual purpose of sweeping the sweep frequency generator as well as deflecting the CRT beam.

4-10. DETAILED CIRCUIT ANALYSIS.

4-11. R-F TUNER.

4-12. OSCILLATORS 1 AND 2.

4-13. Shown in figure 7-3 is the electrical schematic of the two segments of the oscillators 1 and 2 unit. Each segment (oscillator 1 or oscillator 2) consists of an oscillator stage and a mixer stage. The oscillator 1 segment consists of a 6AN4 (V2503) tube, in a push-pull oscillator circuit, generating frequencies between 170 and 320 megacycles. Also part of the oscillator 1 segment is the mixer stage using triode 6AN4 (V2504) which receives the 10-150 mc input signal and mixes it with the output signal from V2503. The oscillator 2 segment uses a 6AN4 (V2501) tube, generating frequencies between 300 and 530 megacycles. Also part of the oscillator 2 segment is the mixer stage using triode 6AN4 (V2502) which receives the 150-350 mc input signal and mixes it with output signal from V2501.

4-14. All supply voltages to the operating stages of oscillators 1 and 2 originate from the power supply and video unit in the indicator drawer. Plate supply voltage (+150V) is supplied to the oscillator V2503 through inductance L2510, and resistances R2508 and R2516. Filament voltage (6.3V ac) is supplied to V2503 through inductance L2511. Plate voltage is applied to mixer V2504 through inductance L2513 and resistance R2510, R2514 and R2517. Filament voltage is supplied to V2504 through inductances L2515 and T2503. For oscillator V2501, plate voltage is supplied through inductances L2501 and L2502 and resistance R2501. Filament voltage is applied through inductances L2508 and T2501. For mixer V2502, plate voltage is supplied through inductances L2501 and L2503 and resistances R2502 and R2507. Filament voltage is applied through inductances L2508 and T2502.

4-15. The V2501 oscillator, stage 2 is particularly suitable for frequency generation in the range of 300-530 mc, because feedback can be added between the plate and cathode of V2501 (6AN4). Capacitor C2506 (.22 mmfd) is used to provide the feedback from plate to cathode of V2501. Capacitor C2503 is made variable by manual control of the "TUNE" knob on the tuner-drawer panel. Varying this capacitance shifts the frequency of oscillation between 300 and 530 megacycles. The tuned circuit of this oscillator is not a normal type of tuned circuit. A parallel wire transmission line is used to transform the impedance of the variable capacitor C2503 to a variable inductance at the tube terminals so that, as the capacitor is varied, tube V2501 "sees" a varying inductance. This inductance is tuned with the plate-grid capacity of V2501, capacitance C2505, the capacity presented by the tube due to the plate to cathode and grid to cathode capacitance, and the mutual conductance of the tube.

4-16. The output of oscillator V2501 is picked off at the plate which is capacitivaly coupled to T2502. In this way, the output of V2501 is fed to the input of mixer V2502 by way of capacitor C2527. The input signal to the

analyzer, which passes through capacitor C2510, is combined with the oscillator output signal at the cathode of mixer V2502. The output signal in the plate circuit of mixer V2502 is 160 megacycles in frequency, and is then fed to the 160-megacycle I-F amplifier.

4-17. The V2503 oscillator, stage 1, is different than oscillator 2. The circuit is quite standard and presents no unusual features. It is suitable for frequency generation in the range of 170 mc to 320 mc. Capacitor C2529 provides feedback from plate to grid of V2503. Capacitor C2517 is made variable by manual control of the "TUNE" knob on the tuner-drawer panel. Varying this capacitance shifts the frequency of oscillation between 170 mc and 320 mc. Capacitor C2518 is used for calibration. Coupling to the mixer, V2504, is obtained thru capacitor C2528 which feeds the signal to T2503. The output signal in the plate circuit of mixer V2504 is 160 megacycles in frequency, and is fed to the 160 megacycle I-F amplifier.

4-18. Both mixer stages in oscillator 1 and 2 unit perform the function of converting the signal to be inspected into the frequency range of 147.5 to 172.5 megacycles. Triodes are employed primarily to reduce noise. To use triode mixers at such high frequencies, the grids must be grounded or oscillations will occur. In addition, the grounded grid mixers provide a low input impedance for matching the impedance of the 50-ohm systems required. The plate circuits of both mixers are double tuned in order to obtain the wide band width required. The chokes in the filament circuits of both mixers are used to keep the cathodes further off ground.

4-19. OSCILLATOR 3 AND OSCILLATOR 4.

4-20. The theory of operation of both oscillator 3 and oscillator 4 are similar, therefore only oscillator 4 will be explained. Oscillator 4 is used as the local oscillator for the spectrum analyzer range of 1000 mc to 16,000 mc. The oscillator circuit shown in figure 7 employs a modified uhf type triode 5675 (V2401) operating with an external resonant cavity. The entire assembly includes a pair of concentric transmission lines built up mechanically of three metal cylinders mounted coaxially one within the other. The innermost cylinder is in contact with the cathode, the center cylinder is coupled to the grid, and the outer cylinder is capacity coupled to the plate.

4-21. The outer concentric line built up of the two outer cylinders constitutes the resonant cavity. This line is short-circuited at a point one-quarter wavelength from the input, electrically forming the equivalent of a parallel resonant circuit between the plate and the grid. The inner concentric line, which is short-circuited approximately at the quarter-wave point, presents a reactance between the grid and the cathode. A screw, set into the outer cylinder, controls the frequency at the lower end of the range. In oscillator 3 this screw also controls the amount of feedback in addition to frequency control. A loading slug is mounted on the back wall of the grid piston and the plate piston to suppress back cavity leakage.

4-22. The oscillator frequency is determined by the resonant frequency of the plate line. By changing the position of the piston the resonant frequency of the line changes. A similar piston is located in the grid-cathode line. Both pistons are secured to the same geared-drive mechanism so that both are moved in unison by the "TUNE" control, which varies the oscillator frequency throughout its range. In oscillator 3 the pistons are of the contacting type, which tune the lines by shorting them. In oscillator 4 the pistons are non-contacting and tune the lines by capacity.

INFORMATION NOTE: When operating above 1000 mc, confusion may arise as to which band an observed frequency is actually on. To determine actual frequency, set the Spectrum Width control to 25 mc and rotate the tuning knob to move the signal from one edge of the screen to the other. On only one band will this correspond to 25 mc in calibration divisions. On higher bands, it will be 50 mc or 100 mc. On lower bands, 12-1/2 mc or 6-1/4 mc.

4-23. 160-MC I-F AMPLIFIER.

4-24. Shown in figure 7-7 is the electrical schematic of the 160-mc amplifier. The amplifier consists of a narrowband (5 mc) I-F amplification section and a wideband (25 mc) I-F amplification section. The narrowband section is made up of three (triple) I-F stages V2208, V2209, and V2210. The wideband section is made up of six (two triples) I-F stages V2201, V2202, V2203, V2204, V2205 and V2206, plus a seventh stage, V2207, which is a cathode follower.

4-25. Plate voltage (Narrow B_+, 150 V) is supplied to the triple in the narrowband section by way of inductances L2226, L2224, L2223, L2221, and L2220. Plate voltage (Wide B_+, 150 V) is applied to the first four I-F stages of the wideband section V2201, V2202, V2203, and V2204 by way of inductances L2212, L2209, L2206, and L2203. Plate voltage (+150 V) is supplied to stages V2205, V2206, and V2207 through inductances L2217, L2215 and resistances R2226, R2222, and R2218. The supply of plate voltage is split in such a manner to permit operation of only such stages as are selected by means of the "BAND SELECTOR" switch S2001 (explained in paragraph 4-32). The band switch arrangement in the tuner drawer permits the removal of Wide B_+ from stages V2201, V2202, V2203, and V2204 when the switch is on "10-150 MCS NARROW" and the removal of

Narrow B+ from stages V2208, V2209, and V2210 when the switch is on "10-150 MCS WIDE". In addition, such switching operation does not affect the supply of plate voltage to stages V2205, V2206, and V2207, which also pass the frequency marker signal from the spectrum calibrator.

4-26. The output signal from one of the input mixers (160 mcs) enters the input of the 160-mc I-F amplifier through selector switch S2201 (A or B deck of "BAND SELECTOR" switch). Shown in the schematic of Figure 7-7 is a table revealing the position of the "BAND SELECTOR" switch S2201 and the corresponding contacts connected for each position. With the switch on "10-150 MCS NARROW", the output of mixer V2504 will feed to the input of the narrowband I-F amplifier V2208 because contact 11 of switch S2201A connects with contact 12. Similarly, with the switch on "10-150 MCS WIDE", the output of mixer V2504 will feed to the input of the wideband I-F amplifier V2201 (by way of inductance L2202) because contact 10 of switch S2201B connects with contact 12. On all remaining positions of the "BAND SELECTOR" switch, either the output of mixer V2502, the crystal mixer associated with oscillator 3, or the crystal mixer associated with oscillator 4 will feed to the input of the wideband I-F amplifier V2201.

4-27. All the tubes used in the 160-mc I-F amplifier are type 6AK5 possessing a gold-plated grid to obtain maximum gain with a minimum of noise. All stages are tuned with minimum capacity in order to obtain maximum gain. Each of the pentode stages is a typical r-f pentode amplifier, the only difference being the addition of a resistance (22 ohms) between pins 2 and 7. In addition, the first I-F amplifier stages (V2201 and V2208) in both the narrowband section and wideband section contain a 51-ohm cathode resistor (R2204 and R2233) and a 39,000-ohm screen resistor (R2201 and R2231) to provide minimum noise generation.

4-28. The input wideband signal to the wideband section is amplified by four I-F stages V2201, V2202, V2203, and V2204, the signal being amplified further by I-F stages V2205 and V2206. The signal is then fed to the cathode-follower stage V2207 which is the output of the 160-mc I-F amplifier. The output signal of the cathode follower is then fed to the 64-mc I-F amplifier in the indicator drawer by way of the interdrawer cable. The cathode-follower stage V2207 is utilized to approximately match the output impedance of the 160-mc I-F amplifier with the interdrawer cable. The 25-mc bandwidth in the 160-mc I-F amplifier unit is obtained by the use of two staggered triples, each triple being approximately 30 megacycles wide. In cascade, the overall bandwidth reduces to the range of 25 to 30 megacycles.

4-29. The narrowband input signal to the narrowband section is amplified by three I-F stages V2208, V2209, and V2210. The output from stage V2210 is fed to the control grid of tube V2206, through capacitor C2238, and amplified further. The output of amplifier V2206 is then fed to the cathode follower V2207. The 5-mc bandwidth is obtained by preceding the second 25-mc triple (stage V2206) with two synchronously tuned stages (V2208 and V2209).

4-30. The output attenuation of the 160-mc I-F amplifier is made controllable by use of the "IF ATTENUATION - DB" switch on the tuner-drawer panel. By manipulating the switch, the cathode resistance of the first triple (V2201, V2202, V2203 and V2204) in the wideband side, and the first three tubes (V2208, V2209, V2210) in the narrowband side, is made to vary. The cathode resistance of the first triple and of the first three tubes, in the narrowband side are connected in series with resistors on the attenuator switch S2202, A and B, on the tuner-drawer panel. Effectively, the cathode resistance is increased by inserting increased resistance values in series with the zero db resistance. On the attenuator switch S2002 are mounted a number of resistors arranged in such a manner to permit the addition of resistance to the cathode resistance at each progressive step position.

4-31. The frequency marker signal from the spectrum calibrator enters the 160-mc I-F amplifier through capacitor C2244 and is fed to the control grid of tube V2205. The signal is introduced into the second triple so that it appears with the same relative amplification for both the narrowband signals, and so that it can be swept flatly over the full 25-mc bandwidth. Introduction of the frequency marker signal into the second triple also allows the signal to be the same amplitude regardless of the position of attenuator switch S2002.

4-32. FUNCTIONAL OPERATION OF R-F TUNER CONTROLS. Shown in figure 7-2 is a schematic of the tuner-drawer, indicating the electrical layout of the controls on the drawer panel. The controls shown schematically are the "BAND SELECTOR" switch S2001 (decks A, B and C) and the "IF ATTENUATION - DB" switch S2002 (Decks A-B and C-D). The schematic also contains a table revealing the position of the "BAND SELECTOR" switch S2001 and the corresponding contacts of each deck connected for each switch position. The B deck of the selector switch is used to transfer the + 150 volts (plate voltage supply) from the output of the power supply and video unit to the narrowband stages or the wideband stages of the 160-mc I-F amplifier. The C deck of the selector switch is used to transfer the + 150 volts (plate voltage supply) from the output of the power supply and video unit to oscillator 1 or 2, or 3, or 4. The A deck of the selector switch is used to transfer the 6.3-volt filament voltage from the power supply to the sixteen indicator lamps I2001 to I2016. The lamps are used to illuminate the selected frequency scale to be read on the "FREQUENCY IN MEGACYCLES" dial. The "IF ATTENUATION - DB" switch S2002 controls the output attenuation of the 160-mc I-F amplifier. As the switch is rotated clockwise, resistances are effectively added to the cathode circuit resistance of the

wideband and narrowband stages of the 160-mc I-F amplifier, the A-B decks of switch S2002 providing wide attenuation, and C-D decks providing narrow attenuation. The 26 resistors (R2001 to R2025 and R2028) are mounted on the attenuator switch S2002 and are arranged functionally to permit the addition of series resistance to the cathode circuit resistance at each progressive step position of the switch knob. The attenuation is increased in steps of 6 db, the range of the switch being from 0 to 60 db.

4-33. ANALYZER INDICATOR.

4-34. PRIMARY POWER DISTRIBUTION.

4-35. Shown in figure 7-12 is a schematic showing power distribution to the analyzer. Input power, 115-volts, 50-400 cycles per second, is supplied through two fuses F1001 and F1002. The "POWER" switch S1004, shown in the open ("OFF") position, is used to control the input power to the equipment. With the power switch closed, 115 volts is fed to the high-voltage power supply, and a regulated 90 volts ac to the power supply and video unit. The power supply and video unit produces three regulated output voltages (+150 V dc, -150 V dc, and 6.3 V ac). The three output voltages are fed to the 160-mc I-F amplifier, 1-mc I-F amplifier, 64-mc I-F amplifier, and the sweep frequency oscillator. The +150-V d-c output is plate supply voltage and the 6.3-V ac output is filament supply voltage. In addition, the 6.3-V ac supply is used as a source for the indicator lamp I1003 which, when lit, indicates to the operator that power is being delivered to the instrument from an external source. The scale-illumination indicators I1001 and I1002 also use the 6.3-V a-c supply as a source, the indicators being controlled by use of the switch-potentiometer control ("SCALE ILLUMINATION") S1001 and R1003. The lamps illuminate the reticle in front of the cathode-ray tube screen.

4-36. The meter selector circuit consists of milliammeter M1001, "METER SELECTOR" switch S1002A and B, resistors R1011 and R1012, selenium rectifier CR1002, and resistor R1013. This circuit is used to check the power supply and video output voltages (+150 V dc and -150 V dc), also enabling a check to be made on the presence of line voltage (115 V ac). The milliammeter M1001 functions as a voltmeter when the multipliers R1011, R1012, and R1013 are placed in series with the meter. The resistances are placed in series with the milliammeter by use of selector switch S1002. Shown in the schematic is a table revealing the position of the "METER SELECTOR" switch and the corresponding contacts connected for each switch position. Selector switch S1002 is shown in the schematic as being in the "+150 V" position. In this position, resistor R1011 is placed in series with the milliammeter so that the meter reads +150 volts dc with respect to ground. With selector switch S1002 in the "-150 V" position, the positive side of the milliammeter becomes grounded through the A deck, while resistor R1012 is placed in series with the meter through the B deck. With meter M1001 grounded as such, the positive side of the meter still remains more positive than the negative side so that, effectively, the meter will read the voltage between the -150 volts line and ground. In the "LINE VOLTS" position, the meter M1001 will read 115 volts dc, the rectified input voltage, 115 volts ac. In this position, the a-c voltage is rectified by selenium rectifier CR1002, and resistor R1013 is placed in series with the meter.

4-37. SPECTRUM CALIBRATOR.

4-38. Shown in figure 7-6 is a schematic of the spectrum calibrator. The spectrum calibrator is a push-pull oscillator, operating in the frequency range of 145 to 175 megacycles. A dual triode type tube 12AT7 (V1401) is used. Since the oscillator is push-pull, it is quite stable for the specified operating frequency range.

4-39. The spectrum calibrator circuitry is physically divided into two assemblies: the attenuator unit Z1001 and the spectrum calibrator unit. The sealed attenuator unit is mounted in back of the front panel of the indicator drawer and contains a switch-potentiometer control S1003 and R1014. The remaining components of the spectrum calibrator circuitry shown on the schematic are located in the spectrum calibrator unit. The attenuator unit Z1001 performs two functions: to control the plate supply voltage from the power supply and video unit to the oscillator, and to control the output attenuation of the oscillator. With switch S1003 in the on position ("CLOSED"), the plate supply input voltage (+150 V) to the spectrum calibrator is fed to inductances L1401, L1403, and L1404. The potentiometer R1014 ("AMPLITUDE") is used to vary the output signal of the oscillator which is fed to the 160-mc I-F amplifier in the tuner-drawer. The spectrum calibrator unit is powered thru switch S1003.

4-40. The oscillator tank circuit consists of capacitors C1403, C1404, C1409 and inductance L1404. The output of the oscillator is obtained by an inductance L1405 which is inductively coupled to the oscillator tank circuit. The oscillator output passes through a T-pad of resistors (R1405, R1406, and R1407) and then to the attenuator unit Z1001. The variable capacitor C1404 is a trimmer capacitor used to account for changes in replacement of tube V1401. Only a small portion of capacitor C1403 is used due to the small frequency range of the oscillator Capacitor C1403 is varied by use of the "SPECTRUM CALIBRATOR" frequency control ("FREQUENCY") on the panel of the indicator drawer. Capacitor C1403 is coupled to this control through an insulated bushing. The spectrum calibrator signal is introduced into the second triple of the 160-mc I-F amplifier so that it is available for operation, regardless of whether wide or narrow position is used, and regardless at which position the step-attenuator control "IF ATTENUATION - DB" is set.

4-41. 64-MC I-F AMPLIFIER.

4-42. Shown in figure 7-9 is a schematic of the mixer stage V1101, which is the input stage of the 64-mc I-F amplifier. The remaining stages of the 64-mc I-F amplifier, which consists of four I-F amplifier stages V1002, V1103, V1104, and V1105 are illustrated in figure 7-9 and discussed in subsequent paragraphs. The two input signals to the triode mixer V1101 are derived from the sweep frequency generator and the 160-mc I-F amplifier. The signal from the sweep frequency generator is fed to the grid of mixer V1101, while the signal from the 160-mc I-F amplifier is fed to the mixer cathode. At this point of the circuitry, only those signals converted to 160-mc are desired at the cathode of the mixer therefore a low pass filter, Z1002, having a cut-off of 185-mc, is inserted between the output of the 160-mc I-F amplifier and the input of the 64-mc I-F amplifier strip, to prevent unwanted signals of oscillator 1 (when in operation) from "riding through" into the mixer stage, V1101. The two signals are combined in the triode and the output appears in the tank circuit L1101, C1103, and C1125, which is tuned to 64 megacycles. The 64-mc output signal is then fed to the control grid of the first I-F amplifier stage V1102.

4-43. The triode mixer is used to reduce noise, thereby increasing the sensitivity. The triode mixer functionally operates under grounded-grid conditions at the signal frequency of 160 megacycles. The values of the cathode resistor R1102 and the plate-dropping resistor R1104 in the mixer provide good mixing operation consistant with low noise level.

4-44. Shown in figure 7-9 is a schematic of the amplifier stages in the 64-mc I-F amplifier. The sensitivity of the 64-mc I-F amplifier unit under normal operating conditions is about 4.5 to 6 microvolts for a signal-to-noise ratio of two to one when the input signal is 160 megacycles (dispersion set at 10-mc). The bandwidth of the amplifier is in the order of 250 kilocycles. Each of the four i-f amplifier stages, incorporating pentode type tubes, amplify the 64-mc input signal. The output signal in the last i-f amplifier stage V1105 is then fed to the mixer stage V1202 in the 1-mc i-f amplifier. The output of each amplifier stage contains a tuned circuit similar to the tuned circuit used in the output of the mixer V1101. All coils in the output of each I-F amplifier stage are tapped to reduce loading on the tuned circuits due to the input conductance of the following tube.

4-45. The first pentode amplifier stage V1102 contains a 51-ohm cathode resistance R1107 and a 39,000 ohm screen-dropping resistance R1108 in order to place the equivalent-noise resistance of this tube at a minimum. The capacitors C1108, C1112, C1116, and C1120 are 510 mmfd in value, being used as by-pass capacitors. The 100-ohm resistors R1109, R1114, R1119, and R1124 prevent the formation of a high-Q resonant circuit, which might result between each of the capacitors just mentioned and the corresponding B+ bypass capacitors C1110, C1114, C1118, and C1121. The second amplifier stage V1103 contains a variable resistor (screwdriver adjust) R1112 for presetting of overall noise level of this stage. Clockwise rotation of the shaft of this gain control increases the gain by decreasing cathode resistance and thus the bias. Front panel control of gain is obtained by R1025 (25, figure 2-1), "2ND IF GAIN". The screen resistor R1113 prevents the 140-volt rating of tube V1103 from being exceeded for various settings of the noise level control R1112. The third amplifier stage V1104 contains a larger cathode resistance R1117 in order to decrease the gain of this stage for the purpose of cutting down overall regeneration.

4-46. The 10-ohm resistors R1106 and R1121 in the plate circuit of tube stage V1102 and tube stage V1105, respectively, are anti-parasitic resistors. The tuned circuit in the plate of amplifier V1105 contains a different coil-capacitor combination that the previous stages. The tuned circuit of amplifier V1105 is used primarily for impedance matching, not contributing much to the selectivity of the amplifier. Note that the 64-mc I-F amplifiers make use of a plexicon tube socket which contains built-in bypass capacitors. The capacitors are marked with an asterisk on the schematic, figure 7-9, and are used as bypass capacitors for the cathode, screen, and heater elements of each amplifier tube. The bandwidth of the amplifier is in the order of 250 kilocycles.

4-47. 1-MC I-F AMPLIFIER.

4-48. The 1-mc I-F amplifier unit consists of four major functional segments: The 32.5-mc local oscillator, 65-mc doubler V1201, mixer V1202, 1-mc amplifier V1203 and phase inverter V1204 and square law amplifier V1205, V1206. Shown in figure 7-10 is a schematic of the 32.5-mc local oscillator and doubler. This segment consists of a crystal-controlled oscillator and a frequency doubler. The crystal Y1201 is used to generate a frequency of 32.5 megacycles. The V1201 tube is a dual triode (12AT7WA), the first half of which is utilized as a 32.5-mc oscillator and the second half of which is used as a frequency doubler. The oscillator used is of the plate-to-cathode feedback type, feedback taking place through capacitor C1204. The output of the oscillator is fed to the grid of frequency doubler V1201 through capacitor C1207. This stage operates under Class C conditions. A tuned circuit, consisting of capacitor C1206 and inductor L1205, is used in the plate circuit of the frequency doubler and is tuned to 65 megacycles. The 65-mc output signal is fed to the suppressor grid of mixer tube V1202.

4-49. Shown in figure 7-10 is a schematic of the mixer V1202. This stage receives two input signals, one at a frequency of 65 megacycles and the other at a frequency of 64 megacycles. The resultant beat signal at the output of the mixer is one megacycle. The output of the mixer is then fed to the 1-mc amplifier. The 65-mc

input signal to the mixer is derived from the output of the 65-mc local oscillator and is fed to the suppressor grid of tube V1202. The 64-mc input signal to the mixer is derived from the output of the 64-mc I-F amplifier and is fed to the control grid of tube V1202 through a transformer T1201. This transformer is used for matching the impedance of the 50-ohm cable which feeds the 64-mc signal from the 64-mc I-F amplifier to the transformer T1201. This transformer is tuned to 64 megacycles and, in addition, feeds a voltage to the tapping point on the cathode resistor in order to provide proper bias to the tube for mixing. The plate circuit of this tube contains a tuned circuit Z1201, tuned to one megacycle. The coil L1 of this tuned circuit is tapped in order to reduce the loading on the coil and preserve the Q characteristic, thus giving better selectivity.

4-50. Shown in figure 7-10 is a schematic of the 1-mc amplifier stage V1203. The 1-mc input signal to the amplifier is fed to the control grid of V1203. The amplified output signal appears in the tuned circuit Z1202, which is identical to the tuned circuit Z1201 in the mixer output stage, coil L1 in Z1202 also being tapped. The output signal of the amplifier is fed to a phase inverter through capacitor C1220.

4-51. Shown in figure 7-10 is a schematic of the phase inverter stage V1204 and square law amplifier stage V1205, V1206. The output of the 1-mc amplifier stage V1203 is fed to the grid of the second half of phase inverter V1204. This inverter is of the cathode-coupled type. The input signal applied to the grid of the second half of the phase inverter is also fed to the grid of the first half of the inverter thru resistors R1219 and R1215. The phase inverter stage produces two output signals which are 180 degrees out of phase. Each output signal is fed to the control grid of a square law amplifier and linear detector. One output signal is fed to amplifier V1205 through capacitor C1223, while the other output signal is fed to amplifier V1206 through capacitor C1224. The test point TP1201 is provided in the cathode circuit of the inverter to permit tuning and selectivity measurements of the 1-mc amplifier unit to be made without the introduction of distortion from the square law amplifier.

4-52. The two square law amplifiers, V1205, V1206 constitute a push-pull squaring circuit. The grids are driven push-pull, while the plates are connected in push-push fashion. The result is that the odd-powered harmonics of the grid signal are cancelled out. In addition, the tubes permit the fourth power content of the fourth harmonic to be very low, leaving the d-c component and the square law component to remain. The 6AU6 type of tube used in the squaring circuit possesses a grid-voltage, plate-current characteristic which makes it especially suitable for this squaring circuit. The screen and grid bias voltages for both 6AU6 tubes provide efficient square law operation. Variable resistor R1229 is the amplifier balancing potentiometer and is employed for matching one 6AU6 tube with the other. This is necessary because of the fine differences which exist between the 6AU6 tubes. Since the 6AU6 tube is a squaring amplifier, the signal in the plate circuit of the square law amplifier is two megacycles. This 2-mc signal, therefore, is much easier to filter. Capacitor C1226 performs the filtering action. The plate-load resistors R1237 and R1238 which are 10,000 ohms, provide maximum square-law operation. The +150-volt and the -150-volt leads in the 1-mc i-f amplifier unit are well filtered to prevent interaction between this subassembly and other units. The output of the square law amplifiers are then fed to a linear detector. The output of the detector follows the square law functions of the square law amplifier. R1229 adjust the square law characteristic. A second detector (CR1201 and 1202) is provided. The output of this detector is linear with respect to its input. In this manner linear detection is provided at the detector selector switch.

4-53. A third detector (CR1205 and 1206) is provided. The output of this detector is logarithmic with respect to its input. As the input signal level to this detector is increased, the detection efficiency decreases giving rise to the logarithmic response. R1245 adjusts this detector for 6 db per scale division on the log scale.

4-54. Switch S1005 (26, Fig. 2-1) provides selection of square law, linear or logarithmic detection. The selected signal is fed to the video amplifier in the power supply and video unit. Two reticle scales are provided - one in the center of the scale reads 0 to 24 db. A square law db scale is provided on the right hand side of the scale. This scale must be multiplied by 2 when linear detection is displayed.

4-55. Switch S1003 changes the resolution (bandwidth of the IMC IF) from 10kc on "NARROW" to 50kc on "WIDE". This switch is normally left in the "NARROW" position.

4-56. SWEEP FREQUENCY GENERATOR.

4-57. The sweep frequency generator consists of four functional segments: The reactance modulated oscillator, two r-f amplifier stages, a frequency tripler and a frequency doubler. Shown in figure 7-8 is a schematic of the reactance modulator stage V1501 and a frequency-modulated oscillator stage V1502. The reactance modulator is a pentode, type 6AK5, and the frequency modulated oscillator is a dual triode, type 12AT7, being cathode coupled. The basic center frequency of the reactance modulated oscillator is 37-1/3 megacycles.

4-58. The sawtooth signal from the sawtooth generator in the power supply and video unit is fed to the control grid of the modulator V1501 through resistors R1502 and R1533. The -150-V d-c signal from the power supply unit is fed to the control grid of modulator V1501 through potentiometers R1017 and R1016A, and resistor R1501. Potentiometers R1016B, R1018, R1017 and R1016A, control the fine and coarse centering of the spectrum dis-

play. The reactance modulator is effectively across the tank coil, L1504, of the oscillator V1502. The plate output of the cathode follower half of the triode is fed back to the control grid of the reactance modulator through capacitor C1505 and resistor R1503. The plate of the second half of the triode is tuned by inductor L1504 which is the frequency controlling element of the oscillator. The frequency of the oscillator varies when the reactance across inductor L1504 is changed by the action of the reactance modulator. Inductor L1504 is tuned to 42-43 megacycles on the high end of the range to insure sufficient linearity to exist over the prescribed frequency range (32.8 to 41.9 mc) of the oscillator. The output signal of the oscillator is obtained from the cathode and is then fed to a two-stage r-f amplifier.

4-59. The mutual conductance of the reactance modulator V1501 is varied by changing the negative bias voltage applied to the control grid. The bias is obtained from the "SPECTRUM CENTERING" controls. The controls are part of a bleeder circuit starting from -150 volts dc down to ground. A comparatively large voltage is introduced at the input of the sweep frequency generator, the voltage being divided by a voltage divider network consisting of resistors R1501 and R1504. Resistor R1504 is a large divider (47,000 ohms) and is necessary in order to provide isolation between the centering control and the sawtooth signal input sothat one signal will not load the other. The dynamic deviation of the oscillator is obtained by introducing the sawtooth signal to the control grid of modulator V1501. Capacitor C1501 is a 1000-uufd, feed-through capacitor used to prevent the r-f signal from feeding out of the cable to the power supply unit.

4-60. Shown infigure 7-8 is a schematic of the r-f amplifier section of the sweep frequency generator. Two stages of r-f amplification are employed. The output of the reactance modulated oscillator is fed to the control grid of the first r-f amplifier V1503 through capacitor C1512. The output of the first r-f amplifier is fed to the control grid of the second r-f amplifier V1504 through capacitor C1516. The output of the second r-f amplifier is fed to a frequency tripler which triples the frequency of the reactance modulated oscillator. The type 6AH6 tubes used provide maximum gain. These tubes are of high mutual conductance. The plate resistors R1516 and R1519 are anti-parasitic resistors. Amplifier V1504 operates in a grid-current region, that is, much of the bias is obtained from the grid-leak network. The values of the cathode resistors R1515 and R1518 insure that the ratings of the type 6AH6 tubes will never be exceeded when a signal is absent.

4-61. Shown in figure 7-8 is a schematic of the frequency tripler-doubler segment of the sweep frequency generator. The frequency tripler V1505 and the doubler V1506 utilizes a pentode type tube 5654/6AK5W. The amplified output of the r-f amplifier V1504 is fed to the control grid of the frequency tripler V1505. The tuned plate circuit Z1501 of V1505 is tuned to 112 megacycles. As a result, the signal from the reactance modulated oscillator is tripled and fed to the control grid of doubler V1506. The tuned plate circuit of V1506 is tuned to 224 megacycles. The frequency of the output signal of tripler V1505 is therefore doubled. The frequency-modulated output signal, centered about 224 megacycles, is then fed to mixer V1101 in the 64-mc i-f amplifier unit.

4-62. The frequency tripler V1505 operates under grid current condition. Cathode resistor R1523 insures that the ratings of the tube will not be exceeded. The plate filter Z1501 is a double tuned network which is heavily loaded to give a large bandwidth. The frequency doubler V1506 also operates under grid current condition, having only grid leak bias. This provides for the amount of output required. The filter network in the output of V1506 provides a bandwidth of 55 megacycles. This filter network is tuned with the output cable as a part of the circuit.

4-63. POWER SUPPLY AND VIDEO.

4-64. Shown in figure 7-11 is the schematic of the regulated power supply and video unit. It comprises dual plate supply regulation, plus line voltage regulation. When the "POWER" switch S1004 (10, figure 2-1) is "ON", the primary of transformer T1301 is excited with 90 volts ac. Transformer T1301 has 4 secondary windings which generate 190 volts, 160 volts, 12.6 volts, and 600 volts. The 600 volt winding supplies screen voltage to regulator tubes V1312, V1314. Tube V1315 is an "error amplifier", the operating point of which is set by potentiometer R1701. The "reference" voltage is obtained from V1311. The error voltage is amplified by V1315 and used to constantly control the input grids of regulator tubes V1312, V1314. Transformer T1302 is a controlled reactor having 2 windings connected in series with the ac line. A third winding connected across the regulator tubes V1312, V1314 acts as an impedance to lower the line voltage in the 2 series windings. Action is to all extent instantaneous. The two silicon rectifier bridges rectify the 190 volt and 160 volt supplies. The +150 volts dc produced at the output of the power supply is series regulated by V1309B. Resistor R1381 is the +150-volts adjust control which is accessible on top of the power supply and video chassis. The -150-volts dc produced at the output is regulated by series regulator V1309A. Resistor R1371 is the -150-volt adjust control which is accessible on top of the power supply and video chassis.

4-65. Shown in figure 7-11 is a schematic of the video section of the power supply and video unit. The sawtooth generating circuit shown performs a dual purpose. It modulates the sweep frequency generator signal of 224 megacycles in the sweep frequency generator, and deflects the cathode-ray beam. The sawtooth generator V1305 generates the horizontal sweep frequency which is fed to cathode follower V1306. From the cathode follower V1306 the signal is split. One path leads thru resistor R1338, and the horizontal gain control R1350, to hor-

izontal amplifier V1308. The output of V1308 is delivered to the horizontal deflection plates of the CRT. The other path leads to V1307, the sweep frequency control and dc compensator. Vertical amplification is obtained by V1302 and V1303. This signal is the one being analyzed on the screen of the CRT.

4-66. Note that a portion of the output of video amplifier V1303 is fed to the control grid of the intensifier squaring tube V1304. The output of V1304 is inverted and amplified by V1301. The output of V1301, adjustable by intensifier control R1321 is then fed to the cathode electrode of the CRT. The intensifier circuitry is incorporated to permit brightening of the trace of the CRT screen so that the short transient of the r-f pulse presented can be clearly viewed. To intensify the trace and, at the same time, preserve optimum focus, the out-of-phase signal from V1301 is simultaneously applied to the focus electrode.

SECTION V

ROUTINE MAINTENANCE

5-1. PLATE VOLTAGE SUPPLY. Check and adjust the plate voltage supply in the indicator unit (figure 3-1) using the following procedure:

a. Connect the power cord into a power supply of 115 volts, 50 to 400 cps ac.

b. Place the "POWER" switch (11, figure 2-1) on. The power indicator lamp (14, figure 2-1) must light.

c. Rotate the "METER SELECTOR" switch (15, figure 2-1) to the "LINE VOLTS" position. The voltage reading on the voltmeter (16, figure 2-1) must be approximately 115 volts.

d. Rotate the "METER SELECTOR" switch (15, figure 2-1) to the "+150 V" position. The voltage reading on the voltmeter (16, figure 2-1) must be 150 volts plus or minus 1 volt. If the reading does not fall within tolerance, follow the instructions given in steps f and g of this paragraph for an additional check and the necessary adjustments to be made.

e. Rotate the "METER SELECTOR" switch (15, figure 2-1) to the "-150 V" position. The voltage reading on the voltmeter (16, figure 2-1) must be 150 volts plus or minus 1 volt. If the reading does not fall within tolerance, follow the instructions given in steps f and g of this paragraph for an additional check and the necessary adjustments to be made.

f. Loosen the 15 panel screws (28, figure 2-1) on the indicator unit and slide the drawer forward. (If drawer seems to bind, loosen panel screws of tuner unit, slide unit forward, and release inter-drawer cable from retaining clip. This clip is internally mounted, approximately in back of indicator name plate.) Remove the top cover of the drawer to gain access to the top of the power supply chassis (figure 3-1). Place the positive test lead of a suitable voltmeter into the 150-volt jack, test point 1301 (figure 3-1) color red, on top of the power supply chassis. Place the negative test lead of the voltmeter to chassis ground. Observe the voltmeter reading. If the reading varies considerably from 150 volts, potentiometer R1381 (figure 3-1) requires adjustment as given in step g of this paragraph. Place the negative test lead of the voltmeter into the -150-volt jack, test point 1302 (figure 3-1) colored white, and the positive test lead to chassis ground. Observe the voltmeter reading. If reading varies considerably from 150 volts, potentiometer R1371 (figure 3-1) requires adjustment as given in step g of this paragraph.

g. Remove the voltmeter from the test jacks. Place the "METER SELECTOR" switch (15, figure 2-1) in the "+150V" position and adjust R1381 (figure 3-1) until the voltmeter (16, figure 2-1) on the indicator unit panel reads 150 volts. Place the "METER SELECTOR" switch (15, figure 2-1) in the "-150 V" position and adjust R1371 (figure 3-1) until the voltmeter (16, figure 2-1) reads 150 volts.

h. Replace and secure the top cover of the indicator drawer. Slide the drawer into the instrument case and tighten all panel screws.

5-2. SPECTRUM CENTERING. If the spectra received on the scope screen cannot be properly centered by using the "SPECTRUM CENTERING" controls (9, 10, figure 2-1), perform the following procedure to correct:

a. Loosen the 15 panel screws (28, figure 2-1), and slide the indicator drawer forward.

b. Set the "SPECTRUM CENTERING" "COARSE" and "FINE" controls (9, 10, figure 2-1) to their zero positions. Adjust potentiometer R1016 (figure 3-2) until the centering is restored on the scope screen. Allow setting to remain.

c. Carefully slide the drawer into the instrument case and secure all indicator panel screws.

5-3. SPECTRUM WIDTH. If the full 25-mc sweep cannot be obtained by using the "SPECTRUM WIDTH" control (21, figure 2-1), perform the following procedure to restore the full range:

a. Loosen the 15 panel screws (28, figure 2-1) and slide the indicator drawer forward. Remove the top cover of the drawer to gain access to the power supply chassis (figure 3-1).

b. Set the "SPECTRUM WIDTH" control (21, figure 2-1) to "25" and adjust the potentiometer R1341 (figure 3-1) until the full range of the 25-mc sweep is restored on the scope screen.

c. Replace and secure the top cover of the indicator drawer. Slide the drawer into the instrument case and tighten all panel screws.

SECTION VI

FIELD MAINTENANCE

6-1. PRELIMINARY PROCEDURE.

a. Connect the analyzer power cord to the external supply of 115 volts, 50 to 400 cps ac.
b. Place the power switch (11, figure 2-1) on. The power indicator lamp (14, figure 2-1) must light.

NOTE

Should all the voltages listed in Table IX vary greatly, check the performance of the ac line voltage regulator before making any adjustments. Refer to paragraphs 6-3c to 6-3k for proper procedure. Should only one voltage vary it can be assumed the line voltage regulator is functioning properly.

6-2. HIGH VOLTAGE POWER SUPPLY.

a. Using a Simpson Model 260 (250 volt scale), check the d-c voltage at test points 1601 and 1602 (figure 6-1). Multiply the meter reading by 16. The acceptable values are listed in table IX.
b. Using a Ballantine Model 300, check the ripple voltage present at test point 1601 and test point 1602. The acceptable values are given in table IX.

6-3. POWER SUPPLY.

a. Using a Simpson Model 260, check the d-c voltage present at test points 1301 and 1302 (figure 3-1). The acceptable values are given in table IX. If the indication is abnormal, adjust R1381 (figure 3-1) for test point 1301, and R1371 (figure 3-1) for test point 1302.
b. Using a Ballantine Model 300, check the ripple voltage at test point 1301 and test point 1302. The acceptable values are given in table IX.
c. The line voltage regulator rarely requires adjustment. However, after replacement of V1312, V1314 or V1315, adjustment may be required. Proceed as follows:
d. Connect spectrum analyzer power cord to a variac, power switch off.
e. Connect the variac to an external supply of 115 volts, 50 to 400 cps ac.
f. Connect an ac voltmeter, 150 V range, to terminals 1 and 2 of power transformer T1301.
g. Turn on spectrum analyzer power switch.
h. Adjust R1701 (figure 3-1) so that the meter across the power transformer reads 91 volts.
i. Advance variac in 5 volt steps from 105 up to and including 125 volts, while observing the meter across T1301 which must read 91 volts (within 1 volt) throughout.

TABLE IX. VOLTAGE CHECKS

TEST POINT	VOLTAGE AND TOLERANCE	RIPPLE TOLERANCE
(7) TP1601	+2500 ±150 volts	Less than 1.5 volts
(8) TP1602	-2500 ±150 volts	Less than 1.5 volts
(5) TP1301	+150 ±1 volt	Less than 5 mv.
(6) TP1302	-150 ±1 volt	Less than 5 mv.

6-4. LINEARITY.

a. Connect a Hewlett Packard Model 608 to test point J1201 (figure 6-1). Set the Model 608 output to 64 mc at 1000-cps, 30% modulation.
b. Adjust R1356 (figure 3-1) for an evenly spaced pattern on the scope screen.
c. Adjust R1001 "ASTIGMATISM" (figure 3-1) and vary the "FOCUS" control for a clear, sharp signal across the spectrum.

6-5. NOISE LEVEL.

a. Adjust peaking coil T1201 (figure 6-1) for maximum amplitude of noise.

b. Set the "VERT GAIN" knob (23, figure 2-1) at maximum, fully clockwise.
c. Adjust R1112 (figure 6-1) for approximately 1/4-cm average of noise.
d. Set the "VERT GAIN" knob between "3" and "4". The noise level should be barely perceptible.

6-6. SWEEP FREQUENCY.

a. Set the "SWEEP FREQ" knob (22, figure 2-1) to "30". - SYNC OFF.
b. Disconnect cable plug P1015 (figure 3-1) from test point J1302 and connect J1302 to the output of a Hewlett Packard Model 200c at 30 cps.
c. Adjust the "SWEEP FREQ" knob (22, figure 2-1) to obtain a single sine-wave indication on the scope screen. If this cannot be obtained, adjust R1331 (figure 3-1) until a single sine-wave indication is observed.
d. Check the "SWEEP FREQ" knob at "25" and "20", varying the Model 200c output accordingly.

6-7. VIDEO AMPLIFIER.

a. Connect a Ballantine Model 300 to the Hewlett Packard Model 200c output.
b. Connect the Model 200c to J1302 (same as step 6-6b).
c. Set the Model 300 on the 1-volt scale and the gain on the model 200c to 16 on the db scale.
d. Set the "INTENSIFIER" (19, figure 2-1) fully counterclockwise; "VERT GAIN" knob (23, figure 2-1) to obtain 5-cm deflection of signal.

NOTE

Do not change this setting throughout the test procedure.

e. Vary the Hewlett Packard Model 200c gain control to obtain a 5-cm deflection of signal on the scope screen for each of the following frequencies: 20 cps, 60 cps, 100 cps, 300 cps, 500 cps, 700 cps, 1 kc, 3 kc, 5 kc, and 8 kc. The reading on the Ballantine Model 300 must be flat within 2 db.

6-8. SPECTRUM CALIBRATOR.

a. Connect an LA-6 at 160 mc to test point 4 (figure 2-2).
b. Set the "AMPLITUDE" knob (5, figure 2-1) of the "SPECTRUM CALIBRATOR" to obtain 3-cm deflection of signal on the scope screen.
c. Zero-beat the "SPECTRUM CALIBRATOR" against the 160-mc input by varying the "FREQUENCY" knob (6, figure 2-1).
d. Loosen the "FREQUENCY" knob and set it to "0". If this adjustment does not permit full range of the control adjust the shaft.
e. Set the "SPECTRUM WIDTH" knob at minimum width.
f. Adjust R1016 (figure 3-2) to bring the indication in the center.
g. Zero-beat the signal from the LA-6 against the calibrator signal for the following frequencies by varying the "FREQUENCY" knob (6, figure 2-1) above and below the 160-mc ("O") setting: 145 mc, 150 mc, 155 mc, 160 mc, 165 mc, 170 mc, and 175 mc. The calibrator frequency must be within ±0.5 mc.

6-9. SPECTRUM WIDTH.

a. Connect an LA-6 to test point 1 (figure 2-2).
b. Set the "FREQUENCY" knob (6, figure 2-1) to "O" (160 mc); "AMPLITUDE" knob (5, figure 2-1) to obtain 3-cm deflection of signal on the scope screen; "SPECTRUM WIDTH" knob (21, figure 2-1) at minimum width.

NOTE

Use this signal as a marker. Keep the signal on zero by varying the "SPECTRUM CENTERING" knob (10, figure 2-1).

c. Vary the signal from the LA-6 to one end of the trace (5-cm mark) and then to the other end of the trace (5-cm mark), recording the frequency reading at each end. Subtract the lower reading from the higher reading to obtain the bandwidth reading.
d. Repeat step c for all "SPECTRUM WIDTH" dial settings (1, 2, 3, 4, 5, 6, 8, 10, 15, 20, and 25). The full range of the "SPECTRUM WIDTH" knob must not be less than 450 kc, nor more than 28 mc.
e. Adjust R1343 (figure 3-1) to calibrate the low end of the dial, and R1341 (figure 3-1) to calibrate the high end of the dial. If necessary, the "SPECTRUM WIDTH" knob may be reset.

6-10. 160-MEGACYCLE I-F ATTENUATOR.

a. Connect a Hewlett Packard Model 608 signal generator to test point J2204 (figure 6-2). Remove mixer cable first ("SPEC WIDTH" set at 1 mc).

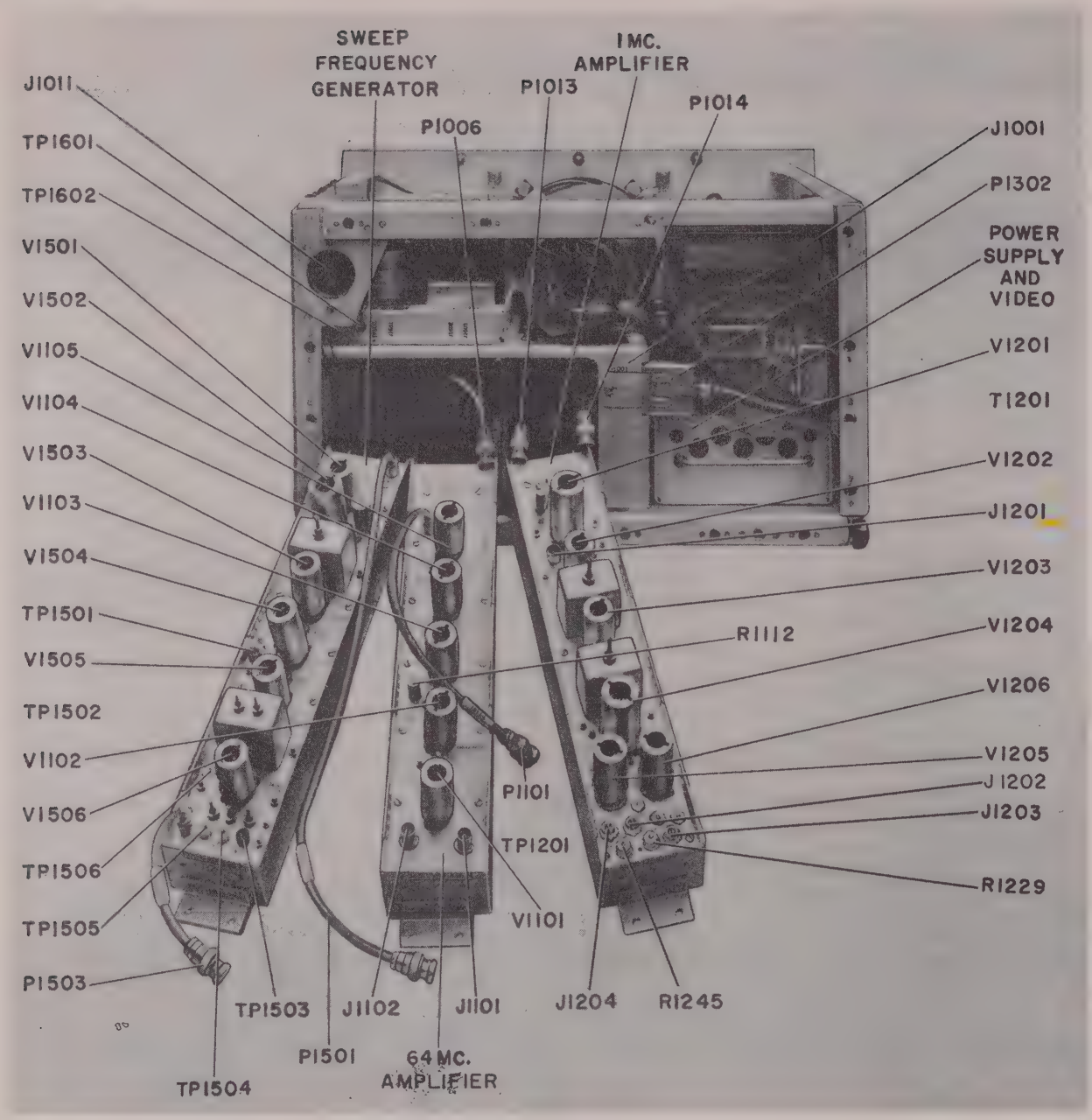


Figure 6-1. Analyzer Indicator, Rear View

b. Set the "BAND SELECTOR" switch (8, figure 2-2) to the "1000-2000 MCS" position; "IF ATTENUATION - DB" switch (6, figure 2-2) to "O".

c. Set the signal generator to 160 mc, cw. Set the attenuator control of the signal generator to obtain 5-cm deflection of signal on the scope screen.

d. Record the attenuator reading of the signal generator in db.

e. Set the "IF ATTENUATION - DB" switch to "54".

f. Set the attenuator control of the signal generator 54 db above step d.

g. Adjust R2022 (figure 6-2) to obtain 5-cm deflection of signal.

h. Set the "IF ATTENUATION - DB" switch to "36".

i. Set the attenuator control of the signal generator 36 db above step d.

j. Adjust R2014 (figure 6-2) to obtain 5-cm deflection of signal.

k. Set the "IF ATTENUATION - DB" switch to "24".

l. Set the attenuator control of the signal generator 24 db above step d.

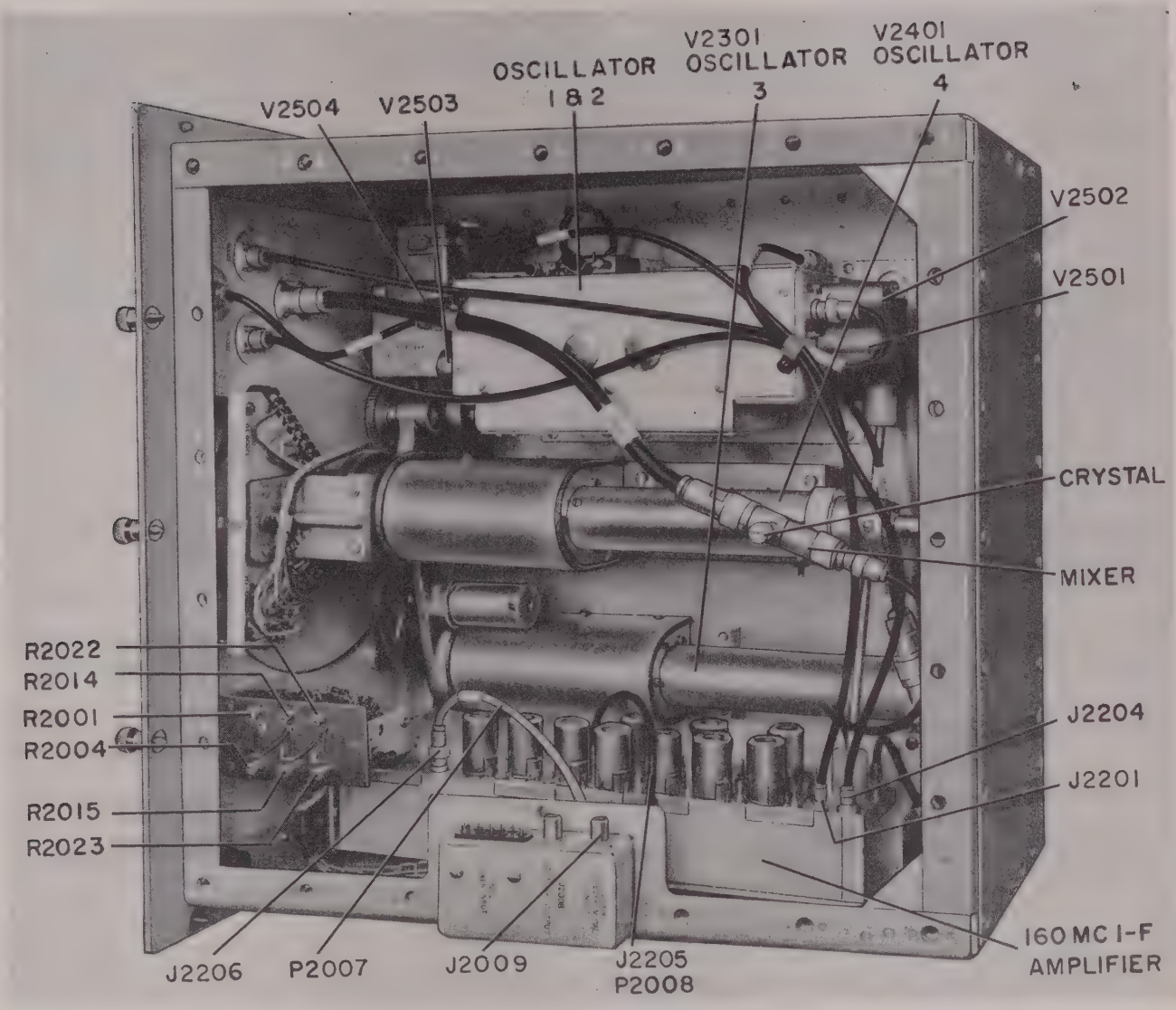


Figure 6-2. R-F Tuner, Top View

m. Adjust R2001 (figure 6-2) to obtain 5-cm deflection of signal.

n. Set the "BAND SELECTOR" switch (8, figure 2-2) to the "10-150 NARROW" position; "IF ATTENUATION - DB" switch (6, figure 2-2) to "0". Connect H-P Signal Generator, Model 608, to J2201 (figure 6-2).

o. Set the attenuator control of the signal generator to obtain 5-cm deflection of signal on the scope screen.

p. Record the attenuator reading of the signal generator in db.

q. Set the "IF ATTENUATION - DB" switch to "54".

r. Set the attenuator control of the signal generator 54 db above step p.

s. Adjust R2023 (figure 6-2) to obtain 5-cm deflection of signal.

t. Set the "IF ATTENUATION - DB" switch to "36".

u. Set the attenuator control of signal generator 36 db above step p.

v. Adjust R2015 (figure 6-2) to obtain 5-cm deflection of signal.

w. Set the "IF ATTENUATION - DB" switch to "24".

x. Set the attenuator control of the signal generator 24 db above step p.

y. Adjust R2004 (figure 6-2) to obtain 5-cm deflection of signal.

z. Check "IF ATTENUATION - DB" switch in the "6", "12", "18", "30", "42", "48", and "60" positions with "BAND SELECTOR" switch in the "1000-2000 MCS" and "10-150 NARROW" positions, and the signal generator connected to test points J2204 and J2201 (figure 6-2), successively. The readings must be within ±2 db, approximately.

6-11. AMPLITUDE COMPARATOR.

a. Set the "FREQUENCY" knob (6, figure 2-1) to "O" (160 mc).

b. Set the "VERT GAIN" knob (23, figure 2-1) to "10". Set the "AMPLITUDE" knob (5, figure 2-1) to obtain between 3- and 4-cm deflection of signal (record this reading).

NOTE

Do not change the settings in step b throughout the procedures given in this paragraph.

c. Disconnect the calibrator cable from test point J2009 (figure 6-2). Connect a Hewlett Packard Model 608 signal generator to test point J2009.

d. Set the signal generator to 160 mc and adjust the attenuator of the signal generator to obtain the same deflection in cm as that obtained with the spectrum calibrator input.

e. Record the attenuator reading of the signal generator in db as the input level for this frequency.

f. Disconnect the signal generator from test point J2009.

g. Set the "FREQUENCY" knob (6, figure 2-1) and the signal generator in step d to 147.5 mc, 150 mc, 155 mc, 160 mc, 165 mc, 170 mc, and 172.5 mc, respectively. Record the input level at each point by repeating steps c through f.

h. Use an insulated screw driver and adjust C1404 (figure 3-2) to obtain a flat signal, within 3 db, the spectrum calibrator from 147.5 to 172.5.

6-12. SWEEP FREQUENCY LINEARITY.

a. Set the "SPECTRUM WIDTH" knob (21, figure 2-1) to "25"; "AMPLITUDE" knob (5, figure 2-1) to "OFF"; "VERT GAIN" knob (23, figure 2-1) between "3" and "4".

b. Connect two LA-6 frequency meters in parallel to test point 1 (figure 2-2).

c. Set one LA-6 to 160 megacycles. Use this signal to monitor the center frequency (160 mc) to eliminate drift that might occur during the test.

d. Set the second LA-6 to 147.5 mc so that a marker appears at the margin of the screen. Shift the frequency of this LA-6 in 2.5-mc steps to 172.5 mc. Markers 2.5 mc apart (tolerance ± .5 cm) should appear evenly spaced at each cm across the trace.

6-13. LINEAR-LOG-SQUARE LAW DETECTORS.

a. Set the "VERT GAIN" knob (23, figure 2-1) to "10" and the 2nd IF GAIN to full counterclockwise.

b. Set the "SPECTRUM WIDTH" knob (21, figure 2-1) to "1".

c. Connect a Hewlett Packard Model 608 to test point 1 (figure 2-2). Set the signal generator to 160 mc, cw.

d. Record the attenuator reading of the signal generator for each 3db step, starting at 0 db on the scope screen reticule.

e. Adjust R1245 to correct the LOG detector and R1229 to correct Square Law Detectors.

6-14. HORIZONTAL AMPLIFIER LINEARITY.

a. Disconnect cable plug P1015 from J1302 (figure 3-1).

b. Connect cable from J1302 to the output jack of pulse generator LA-593.

c. Set the "SWEEP FREQ" knob (22, figure 2-1) to "30"; "VERT GAIN" knob (23, figure 2-1) between "3" and "4"; "SPECTRUM WIDTH" knob (21, figure 2-1) to "25".

d. Set the oscillator frequency dial on the pulse generator to 330 cps; coarse attenuator to 20-200 output; selector to negative narrow; sync selector to 200-2000-cps range.

e. Check the trace on the scope screen. A pulse must appear at each cm ±0.5 cm.

6-15. TUNER CALIBRATION. Check the tuner calibration by zero-beating frequency meter LA-6 (100-500 mc) or frequency meter LA-61 (500-2100 mc) against the spectrum analyzer local oscillators for the appropriate settings of the "BAND SELECTOR" switch and "TUNE" control listed in table X. The tuning dial readings of the spectrum analyzer must be within one percent of the LA-6 or LA-61 frequency.

NOTE

The LA-61 may be used below 500 mc by using harmonics. Oscillators 1, 2, and 3 oscillate 160 mc above the frequency being checked. Oscillator 4 oscillates 160 mc below the frequency being checked.

6-16. OVERALL SENSITIVITY. Check the spectrum analyzer overall sensitivity by following the steps given in table XI through table XIV. The signal+noise-to-noise ratio must be 2- to 1 on the CRT screen for all the overall sensitivity checks.

6-17. SPURIOUS RESPONSES.

a. With no signal input, rotate the "TUNE" control (7, figure 2-2) throughout the dial range for all positions of the "BAND SELECTOR" switch ("10-150 MCS NARROW," "10-150 MCS WIDE," "150-350 MCS", "350-1000 MCS," "1-2 KMCS," "2-4 KMCS," "4-8 KMCS," "8-16 KMCS").

b. Any spurious response, throughout step a, must not be more than twice the amount of the noise level.

6-18. TROUBLE ANALYSIS.

6-19. Table XV is an aid in locating troubles that might occur in the spectrum analyzer. It lists troubles, probable causes, and the remedies to be performed by field maintenance personnel.

6-20. REMOVAL AND REPLACEMENT OF COMPONENTS. Replace defective parts with the same type replacement parts. After replacing any electronic parts in any subassembly, the associated circuit should be checked for its minimum performance standard, as listed in paragraph 6-1 through 6-17, to insure proper operation of the analyzer. If any of the minimum performance standards are not obtained, the associated subassembly must be replaced.

DISASSEMBLY OF COMPONENTS FOR SERVICING.

a. REMOVAL OF INDICATOR UNIT FROM CABINET.

(1) Loosen the 15 panel screws securing unit to cabinet and 8 shipping bolts in rear.

(2) Slide indicator unit part way out.

(3) Detach interdrawer cable from J1003, J1009, J1010, located on bottom of unit. (Refer to paragraph 5-1f).

(4) Place cable flat on cover of tuner unit.

(5) Remove indicator unit from cabinet. (Lift rear of unit to disengage rollers from cabinet slides.)

b. REMOVAL OF POWER SUPPLY AND VIDEO CHASSIS (See figure 6-1). (Allen wrenches for this operation are mounted inside of tuner unit.)

(1) Proceed as in a (1) to a (5).

(2) Remove top and rear covers. These are secured by Dzus fasteners requiring a quarter-turn of a screwdriver.

(3) Detach coax cables P1501, P1015 and P1306.

(4) Detach plug from J1001 at rear of indicator unit.

(5) Remove 8 knobs: "HORIZ CENTERING", "VERT CENTERING", "HORIZ GAIN", "VERT GAIN", "SWEEP FREQ", "SPECTRUM WIDTH", "INTENSIFIER", "SYNC".

(6) Remove screws:

1 screw, between "HORIZ CENTERING" and "VERT CENTERING" on front panel.

1 screw, between "SWEEP FREQ" and "SPECTRUM WIDTH" on front panel.

6 chassis screws, captive type, located along top edge of chassis.

4 large screws and washers, thru bracket plate atop power transformer.

(7) Grasp handle of power unit and pull slowly outward.

NOTE

Use care in removal of components. Rough handling may result in broken parts, tubes, or cables.

c. REMOVAL OF SWEEP FREQ. GENERATOR (see fig. 6-1).

(1) Proceed as in a (1) to a (5). Remove top and rear covers.

(2) Detach cable P1503 from J1102 (located on 64 mc chassis).

(3) Detach cable P1501 from J1303 (located on top of power supply chassis).

(4) Remove the 2 screws securing generator chassis bracket to indicator chassis.

(5) Slide generator chassis slowly outward, guiding cable P1501 thru adjacent components.

d. REMOVAL OF 1 MC IF AMPLIFIER (see figure 6-1).

(1) Proceed as in a (1) to a (5). Remove rear cover.

(2) Detach cable P1013 from J1203.

(3) Detach cable P1014 from J1202 and P1016 from J1204.

(4) Remove 2 screws securing amplifier chassis bracket indicator chassis.

(5) Slide chassis slowly outward until cable P1101 is accessible.

(6) Detach cable P1101 from J1201. Removal of V1101 and shield from 64 mc amplifier will aid this procedure.

e. REMOVAL OF 64 MC IF AMPLIFIER (see figure 6-1).

(1) Proceed as in a (1) to a (5). Remove rear cover.

(2) Because of interconnecting cable P1101, it is advisable to remove the 1 mc amplifier chassis before removing the 64 mc amplifier chassis.

(3) Detach cable P1503 from J1102.

(4) Detach cable from J1101.

(5) Remove 2 screws securing amplifier chassis bracket to indicator chassis.
(6) Slide chassis slowly outward.

NOTE

When re-installing components on indicator chassis, avoid sharp bends in coax cables. Allow cables to assume natural curves, but under no conditions are they to touch hot surfaces such as tubes or resistors.

f. REMOVAL OF HIGH VOLTAGE SUPPLY (see figure 3-1).
(1) Proceed as in a (1) to a (5). Remove top and rear covers.
(2) Detach plug P1003 by removing the two screw fasteners and pulling plug upward.
(3) Detach connector from J1601 by unscrewing knurled collar.
(4) Loosen, but do not remove, the 2 screws holding the upper and lower halves of the CRT base clamping ring.
(5) Loosen, but do not remove, the 3 screws holding the metal flange against the CRT socket.
(6) Rotate the CRT within its magnetic shield until high voltage connector comes into view.
(7) Disconnect high voltage lead by a firm pull on the wire lead. DO NOT TOUCH THE CONTACTS. By means of an insulated wire, having one end connected and grounded to the chassis, discharge both high voltage lead and CRT contact.
(8) Remove 7 screws securing flange of power supply to chassis.
(9) Lift high voltage power supply from main chassis, meanwhile removing cable plug from J1604. This plug fits quite tightly and should be rocked sideways, while pulling outward, to release it.

NOTE

Assembly is the reverse of disassembly procedure. After re-installing the high voltage power supply it will be necessary to realign the baseline on the CRT screen. After alignment, both horizontally and vertically, (preferably with a pulse displayed), tighten the 2 screws of the base clamping ring and the 3 screws of the socket clamping flange.

g. REMOVAL OF SPECTRUM CALIBRATOR (see figure 3-1).
(1) Proceed as in a (1) to a (5). Remove top cover.
(2) Detach P1002 from J1401.
(3) Loosen, but do not remove, 2 Allen head screws in collar of flexible tuning shaft. A pencil mark on shaft collar and adjacent collar, will aid in realigning in relation to tuning dial upon re-installing the spectrum calibrator. (Allen type wrenches are internally mounted in tuner unit.)
(4) Remove 6 screws securing chassis flange to indicator chassis.
(5) Slide unit slowly towards high voltage supply to disengage from power socket.
(6) Refer to paragraph 6-8 for procedure to check dial calibration when spectrum calibrator reinstalled.

h. REMOVAL OF R-F TUNER UNIT (see figure 2-2).
(1) Loosen the 15 panel screws securing unit to cabinet.
(2) Slide tuner unit partway out. (Refer to par. 5-1f.)
(3) Detach inter drawer cable from J2008, J2009, J2011.
(4) Remove tuner unit from cabinet. (Lift rear of unit slightly to disengage rollers from cabinet slides.)

i. REMOVAL OF 160 MC IF CHASSIS (see figure 6-2).
(1) Proceed as in h (1) to h (4). Remove top cover.
(2) Detach cable K81603120 from J2201.
(3) Detach cable K86106070 from J2202.
(4) Detach cable K81606080 from J2204.
(5) Detach cable K81606090 from J2203.
(6) Detach cable P2008 from J2205.
(7) Detach cable P2007 from J2206.
(8) Loosen 2 screws (captive type) at rear corners of amplifier chassis.
(9) Slide amplifier chassis to rear and upward to disengage from power plug.

NOTE

It is advisable to set the Band Selector switch fully CCW to obtain correct indexing when re-installing the 160-mc I-F amplifier chassis.

j. REMOVAL OF OSCILLATOR 1 and 2 ASSEMBLY (see figure 6-2).
(1) Proceed as in h (1) to h (4).
(2) Remove top and rear covers and set mc scale to 0 mcs.
(3) Detach power plug from J2501.
(4) Detach cable P2004 from J2502
(5) Detach cable K81606070 from J2503.
(6) Detach cable P2003 from J2504.
(7) Detach cable K81603120 from J2505.
(8) Detach cable clamps at each end of oscillator cover.
(9) By means of the proper Allen wrench (mounted on side apron of tuner) loosen, but do not remove, the Allen head screws in collar of flexible tuning shaft. It is advisable to mark the collar in relation to the assembly to aid in alignment of tuning dial when assembly is re-installed.
(10) Remove 7 screws securing flange to the tuner chassis.
(11) Slide assembly to rear to disengage tuning shaft.
(12) Lift assembly from tuning unit.

k. REMOVAL OF OSCILLATOR 3 AND OSCILLATOR 4 ASSEMBLIES (see figure 6-2).
(1) It is not advisable to remove oscillator assembly 3 or oscillator assembly 4 in the field. Beyond replacement of V2301 or V2401 (which will require rechecking of dial calibration) the complexity and interrelation of mechanical parts to electronic circuitry deem it advisable to return the r-f tuner drawer to the manufacturer. Inherent mechanical ruggedness makes this unlikely. Removal of plate cap will provide access to tubes. A special tool having a hooked end for removal of heater connection will be found mounted on side apron of tuner unit. Note that oscillator 4 uses a modified 5675 type tube, Lavoie Part No. K80000400.

6-21. VOLTAGE AND RESISTANCE MEASUREMENTS. Listed in table XVI through XXV are voltage and resistance measurements for the spectrum analyzer. All measurements are made with a Simpson Model 260 Multitester under test conditions as stated in each table. Any appreciable variation in voltage, and/or resistance from the specified values, indicates a probable malfunction. The causes for any such variation should be traced and repaired to insure proper operation of the spectrum analyzer.

WARNING

THE HIGH VOLTAGE EMPLOYED IN THIS EQUIPMENT IS DANGEROUS TO HUMAN LIFE. USE EXTREME CAUTION WHEN MAKING VOLTAGE CHECKS. MAINTENANCE PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY PRECAUTIONS.

6-22. ALIGNMENT AND ADJUSTMENTS. The alignment and adjustment procedures for the spectrum analyzer are listed in paragraphs 6-1 through 6-17.

6-23. LUBRICATION. Lubrication is usually unnecessary. However, if excessive dirt or dryness hinders the operation of gear train assembly and lead screws, the following procedure be performed.
a. Clean gear train assembly and lead screws with a typewriter brush.
b. Using Aeroshell Grease 7 (MIL-G-7118) on a clean fingertip, wipe the gear train assembly and the lead screws lightly.

TABLE X. TUNER CALIBRATION

STEP	TEST POINT*	FREQUENCY METER LA-6 SETTING	FREQUENCY METER LA-61 SETTING	"BAND SELECTOR" SWITCH	"TUNE CONTROL"
1	(1) (fig. 2-2)	170 mc		"10-150 MCS WIDE"	"10"
2	Same as step 1	200 mc		Same as step 1	"40"
3	Same as step 1	240 mc		Same as step 1	"80"
4	Same as step 1	280 mc		Same as step 1	"120"
5	Same as step 1	320 mc		Same as step 1	"160"
6	(2) (fig. 2-2)	310 mc		"150-350 MCS"	"150"
7	Same as step 6	360 mc		Same as step 6	"200"
8	Same as step 6	410 mc		Same as step 6	"250"
9	Same as step 6	460 mc		Same as step 6	"300"
10	Same as step 6		510 mc	Same as step 6	"350"
11	(3) (fig. 2-2)		510 mc	"350-1000 MCS"	"350"
12	Same as step 11		660 mc	Same as step 11	"500"
13	Same as step 11		810 mc	Same as step 11	"650"
14	Same as step 11		860 mc	Same as step 11	"700"
15	Same as step 11		1160 mc	Same as step 11	"1000"
16	(4) (fig. 2-2)		840 mc	"1-2 KMCS"	"1000"
17	Same as step 16		1040 mc	Same as step 16	"1200"
18	Same as step 16		1340 mc	Same as step 16	"1500"
19	Same as step 16		1640 mc	Same as step 16	"1800"
20	Same as step 16		1940 mc	Same as step 16	"2100"

*Connect the frequency meter to the test point.

TABLE XI. SENSITIVITY CHECK FOR BAND 10-150 MEGACYCLES*

STEP	TEST POINT	HEWLETT PACKARD MODEL 608 SETTING	"TUNE" CONTROL SETTING	SIGNAL GENERATOR ATTENUATOR READING
1	(1) (fig. 2-2)	10 mc	"10"	Less than 40 uv.
2	Same as step 1	40 mc	"40"	Same as step 1
3	Same as step 1	80 mc	"80"	Same as step 1
4	Same as step 1	120 mc	"120"	Same as step 1
5	Same as step 1	150 mc	"150"	Same as step 1

*NOTE: Set "SPECTRUM WIDTH" knob (21, figure 2-1) to "1"; "BAND SELECTOR" switch (8, figure 2-2) to "150-350 MCS". Connect the Hewlett Packard Model 608 (or equivalent) to the test point.

TABLE XII. SENSITIVITY CHECK FOR BAND 150-350 MEGACYCLES*

STEP	TEST POINT	HEWLETT PACKARD MODEL 608 SETTING	"TUNE" CONTROL SETTING	SIGNAL GENERATOR ATTENUATOR READING
1	(2) (fig. 2-2)	150 mc	"150"	Less than 40 uv.
2	Same as step 1	200 mc	"200"	Same as step 1
3	Same as step 1	250 mc	"250"	Same as step 1
4	Same as step 1	300 mc	"300"	Same as step 1
5	Same as step 1	360 mc	"360"	Same as step 1

*NOTE: Set "SPECTRUM WIDTH" knob (21, figure 2-1) to "1"; "BAND SELECTOR" switch (8, figure 2-2) to "150-350 MCS". Connect the Hewlett Packard Model 608 (or equivalent) to the test point.

TABLE XIII. SENSITIVITY CHECK FOR BAND 350-1000 MEGACYCLES*

STEP	TEST POINT	HEWLETT PACKARD MODEL 608 SETTING	HEWLETT PACKARD MODEL 612A SETTING	"TUNE" CONTROL SETTING	SIGNAL GENERATOR ATTENUATOR READING
1	(3) (fig. 2-2)	350 mc		"350"	Less than 40 uv.
2	Same as step 1	500 mc		"500"	Same as step 1
3	Same as step 1		650 mc	"650"	Same as step 1
4	Same as step 1		800 mc	"800"	Same as step 1
5	Same as step 1		1000 mc	"1000"	Same as step 1

*NOTE: Set "SPECTRUM WIDTH" knob (21, figure 2-1) to "1"; "BAND SELECTOR" switch (8, figure 2-2) to "350-1000 MCS". Connect the Hewlett Packard 608; 613C; (or equivalent) to the test point.

TABLE XIV. SENSITIVITY CHECK FOR BAND 1000-16000 MEGACYCLES*

STEP	SIGNAL GENERATOR	SIGNAL GENERATOR SETTING	"BAND SELECTOR" SWITCH POSITION	"TUNE" CONTROL SETTING	**SIGNAL GENERATOR ATTENUATOR READING (dbm)
1	Hewlett Packard 614A	1000 mc	"1-2 KMCS"	"1000"	50
2	Hewlett Packard 614A	1200 mc	"1-2 KMCS"	"1200"	50
3	Hewlett Packard 614A	1500 mc	"1-2 KMCS"	"1500"	50
4	Hewlett Packard 614A	1600 mc	"1-2 KMCS"	"1600"	50
5	Hewlett Packard 614A	2100 mc	"1-2 KMCS"	"2100"	50
6	Hewlett Packard 614A	1800 mc	"2-4 KMCS"	"1800"	50
7	Hewlett Packard 614A	2100 mc	"2-4 KMCS"	"2100"	50
8	Hewlett Packard 616A	2600 mc	"2-4 KMCS"	"2600"	50
9	Hewlett Packard 616A	3200 mc	"2-4 KMCS"	"4000"	50
10	Hewlett Packard 616A	4000 mc	"2-4 KMCS"	"4000"	50
11	Hewlett Packard 616A	3400 mc	"4-8 KMCS"	"3400"	40
12	Hewlett Packard 618B	4400 mc	"4-8 KMCS"	"4400"	40
13	Hewlett Packard 618B	5500 mc	"4-8 KMCS"	"5500"	40
14	Hewlett Packard 618B	6500 mc	"4-8 KMCS"	"6500"	40

TABLE XIV. SENSITIVITY CHECK FOR BAND 1000-16000 MEGACYCLES* (cont)

STEP	SIGNAL GENERATOR	SIGNAL GENERATOR SETTING	"BAND SELECTOR" SWITCH POSITION	"TUNE" CONTROL SETTING	**SIGNAL GENERATOR ATTENUATOR READING (dbm)
15	Hewlett Packard 618B	7000 mc	"4-8 KMCS"	"7000"	40
16					
17	Hewlett Packard 618B	7000 mc	"8-16 KMCS"	"7000"	40
18	Hewlett Packard 620A	8500 mc	"8-16 KMCS"	"8500"	40
19	Hewlett Packard 620A	9500 mc	"8-16 KMCS"	"9500"	40
20	Hewlett Packard 620A	10000 mc	"8-16 KMCS"	"10000"	40
21	Hewlett Packard 626A	12500 mc	"8-16 KMCS"	"12500"	40
22	Hewlett Packard 626A	13000 mc	"8-16 KMCS"	"13000"	40
23	Hewlett Packard 626A	13500 mc	"8-16 KMCS"	"13500"	40
24	Hewlett Packard 626A	14000 mc	"8-16 KMCS"	"14000"	40
25	Hewlett Packard 626A	14500 mc	"8-16 KMCS"	"14500"	40
26	Hewlett Packard 626A	15000 mc	"8-16 KMCS"	"15000"	40
27	Hewlett Packard 626A	15500 mc	"8-16 KMCS"	"15500"	40
28	Hewlett Packard 628A	16000 mc	"8-16 KMCS"	"16000"	40

NOTE: * Set the "SPECTRUM WIDTH" knob (21, figure 2-1) to "1". Connect the signal generator to test point (4) (figure 2-2).
** Maximum input level.

TABLE XV. TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
B-supply voltage low	Low input power	Check power source
	T1301 defective	Replace
	V1309, V1310 V1311, or V1312, V1313, V1314, V1315 defective	Check for defective tube and replace
Analyzer does not operate in the "10-150 MCS NARROW" position. Operation is normal in all other positions	Narrow band I-F amplifier V2208, V2209, V2210 defective	Check for defective tube and replace
	Switch S2001 or switch S2201 defective	Clean contacts or replace switch as necessary

TABLE XV. TROUBLE SHOOTING CHART (cont)

TROUBLE	PROBABLE CAUSE	REMEDY
Analyzer does not operate above 1000 mc. Operation is normal below 1000 mc.	Oscillator 4 defective	Check crystal, tube, and voltages.
	Switch S2001 or switch S2201 defective	Clean contacts or replace switch as necessary
Analyzer does not operate in the "350-1000 MCS" position. Operation is normal in all other positions	Oscillator 3 defective	Check crystal tube, and voltages
	Switch S2001 or switch S2201 defective	Clean contacts or replace switch as necessary
Analyzer does not operate in the "150-350 MCS" position. Operation normal in all other positions	V2501 or V2502 defective	Check for defective tube and replace
	Switch S2001 or switch S2201 defective	Clean contacts or replace switch as necessary
Analyzer does not operate in the "10-150 MCS NARROW" and the 10-150 MCS WIDE" positions. Operation is normal in all other positions	V2503 or V2504 defective	Check for defective tube and replace
	Switch S2001 or Switch S2201 defective	Clean contacts or replace switch as necessary
Analyzer operates normally in the "10-150 MCS NARROW" position, but does not operate in all other positions	Wide band amplifier V2201, V2202, V2203, V2204 or V2205 defective	Check for defective tube and replace
No output from the spectrum calibrator	V1401 defective	Replace
No vertical sweep on the scope screen. The video input from the 1-mc I-F is normal	V1302, V1303, V1304 or V1307 defective	Check for defective tube and replace
No horizontal sweep	V1305, V1306 or V1308 defective	Check for defective tube and replace
Pattern cannot be synchronized	V1301, V1305, V1306 or V1308 defective	Check for defective tube and replace
	Sweep frequency generator V1501, V1502, V1503, V1504, V1505 or V1506 defective	Check for defective tube and replace
Cannot control the brightness	CRT defective	Replace
	R1004 defective	Replace
	C1003 defective	Replace
No pattern on the scope screen	High voltage power supply defective	Replace
	CRT defective	Replace

NOTE

1. All measurements are made with front panel controls positioned as follows:
   "HORIZ CENTER" ccw — "HORIZ GAIN" ccw
   "VERT CENTER" ccw — "VERT GAIN" ccw
   "SWEEP FREQ" ccw — "SPEC WIDTH" ccw
   "SYNC" ccw — "INTENSITY" ccw
   (ccw, counterclockwise; cw, clockwise)
2. All measurements are made with Simpson Model 260 V. O. M. or equivalent 20, 000 ohm-per-volt dc, 1, 000 ohm-per-volt ac meter.
3. All resistance measurements must be made with equipment turned off and with the tube removed from the socket being measured.

4. All voltage measurements must be made with tubes in socket and equipment turned on. The use of socket test adaptors is indicated.
5. Note the individual test conditions for each chassis as listed in each table. Certain chassis are resistance checked only when detached from the analyzer.

TABLE XVI. 1 MC I-F AMPLIFIER VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS								
		1	2	3	4	5	6	7	8	9
V1201	V	150	-7	0	6.3*	6.3*	150	-.25	0	0
	R	29K	50K	.3	.7	.7	28K	10K	0	0
V1202	V	1.3	6	0	6.3*	150	125	0		
	R	300	1.2K	0	.6	27K	35K	50K		
V1203	V	0	3	6.3*	0	150	150	3		
	R	510K	∞	.6	0	27K	27K	910		
V1204	V	120	24	32	0	0	123	3.2	3.2	6.3*
	R	36K	102.7K	2.8K	0	0	36K	510K	2.8K	.6
V1205	V	-2.6	0	0	6.3*	148	80	0		
	R	50K**	0	0	.6	36K	14K	0		
V1206	V	-3	0	0	6.3*	150	80	0		
	R	68K	0	0	.6	36K	15K	0		
TP1201	V	0								
	R	470K								

* AC Volts
**Will vary with setting or R-1229
Test conditions:
Voltage; chassis removed but connected by special cable.
Resistance; chassis entirely detached from analyzer, tube removed from socket under test.
Chassis as ground. Socket test adapters used.

TABLE XVII. 64 MC I-F AMPLIFIER VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS						
		1	2	3	4	5	6	7
V1101	V	50	-.65	6.3*	0	.5	0	50
	R	∞	47K	2	0	390		∞
V1102	V	-.5	.25	6.3*	0	150	120	.25
	R	350K	∞	1.8	0	∞		51
V1103	V	-.4	0**	6.3*	0	150	95	0**
	R	360K	∞	1.7	0	∞		7K**
V1104	V	-.7	3.2	6.3*	0	150	143	3.2
	R	350K	∞	1.4	0	∞	∞	4.7K
V1105	V	-1	.5	6.3*	0	150	132	.5
	R	340K	∞	1.4	0	∞	∞	200

* AC Volts
**Will vary with setting of R112
Test conditions:
Voltage; chassis removed but connected by special cable.
Resistance; chassis entirely detached from analyzer tube removed from socket under test.
Chassis as ground. Socket test adapters used.

TABLE XVIII. SWEEP FREQUENCY GENERATOR VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS								
		1	2	3	4	5	6	7	8	9
V1501	V	-3***	0	6.3*	0	132	128	0		
	R	47K	0	.8	0	∞	∞	0		
V1502	V	133	-.25	0	0	0	138	-.25	0	6.3*
	R	∞	15K	.3	0	0	∞	22K	.3	.7
V1503	V	0	0	6.3*	0	148	148	1.4		
	R	12K	∞	.8	0	∞	∞	120		
V1504	V	0	0	6.3*	0	148	148	1.4		
	R	2.7K	∞	.8	0	∞	∞	120		
V1505	V	-6.5	.65	6.3*	0	150	120	.67		
	R	35K	∞	.6	0	∞	∞	51		
V1506	V	-1.8	0	6.3*	0	150	106	0		
	R	10K	∞	.6	0	∞	∞	0		
TP1501	V	.25								
	R	80K**								
TP1502	V	.125								
	R	80K**								
TP1503	V	.25								
	R	40K**								
TP1504	V	0								
	R	.1								
TP1505	V	0								
	R	.1								
TP1506	V	-.2								
	R	10K								

* AC Volts.
** Diode involved.
***Varies with "SPECTRUM CENTERING" controls.
Test conditions:
Voltage; chassis removed but connected by special cable.
Resistance; chassis entirely detached from analyzer, tube removed from socket under test.
Chassis as ground.
Socket test adapters used.

TABLE XIX. POWER SUPPLY AND VIDEO VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS								
		1	2	3	4	5	6	7	8	9
V1301	V	150	0	1.	6.1*	6.1*	125	0	.9	0
	R	10K	50K	80K	HTR	HTR	16K	2MEG‡	200	HTR
V1302	V	0	1.6	6.3*	0	15	90	1.6		
	R	1.0	75K	HTR	HTR	110K	75K	75K		
V1303	V	-.7	.9	6.3*	0	15	90	1.6		
	R	1.2K	75K	HTR	HTR	110K	75K	75K		
V1304	V	-.7	0	6.3*	0	146	32	0		
	R	2.2MEG	0	HTR	HTR	14K	490K	0		
V1305	V	-6.3	0	6.3*	0	35	140	1.7		
	R	75K	0	HTR	HTR	670K	33K	5K**		
V1306	V	150	35	40	6.1*	6.1*	150	52	-150	0
	R	12K	68K	50K	HTR	HTR	10K	350K	52K	HTR
V1307	V				6.3*	6.3*	150	38	40	0
	R				HTR	HTR	10K	17K	1MEG	HTR
V1308	V	-55	-123	-122	6.2*	6.2*	-133	-322	-122	0
	R	48K	16K	75K	HTR	HTR	520K	20K	75K	HTR
V1309	V	-20	56	0	125	240	150	6.3*	6.3*	
	R	1MEG	10K	0	1MEG	10K	10K	HTR	HTR	
V1310	V	-20	-62	-60	6.3*	6.3*	-62	-85	-85	0
	R	1MEG	560K	16K	HTR	HTR	560K	70K	16K	HTR
V1311	V	0			-85					
	R	0			16K					
V1312	V	.75	6.3*	310*	250*	-12		0	.75	
	R	10	HTR	150	10.5K	3.6K		HTR	10	
V1313	V	125	53	55	6.3*	6.3*	55	.7	0	0
	R	1MEG	70K	240K	HTR	HTR	240K	70K	0	HTR
V1314	V	.75	6.3*	310*	250*	-12		0	.75	
	R	10	HTR	150	10.5K	3.6K		HTR	10	
V1315	V	-7	0	6.3*	0	60	56	0		
	R	200K	0	HTR	HTR	250K	10K	0		

* AC Volts
**Depends on polarity of meter and scale used. (Diodes involved.)
Test conditions:
Chassis remains in indicator drawer.
Voltage; negative meter lead to chassis except for negative voltage readings. All tubes in sockets.
Resistance; tube removed from socket under test, equipment shut off.
Socket test adapters used for measurements.

TABLE XX. SPECTRUM CALIBRATOR AND CRT VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS											
		1	2	3	4	5	6	7	8	9	10	11	14
V1401	V	150	-1.2**	1.05	0	0	150	-2.0**	1.05**		6.3*		
	R		10K	110	0	0	∞	10K	110		∞		
V1001 (CRT)	V	-2000	-2000	-2100		1700		15	135	130	-32	+133	-2000
	R	4MEG	4MEG	5MEG		4MEG		120K	120K	80K	500K	500K	4MEG

* AC. Volts.
**Will vary with setting of "FREQUENCY" knob.

TABLE XXI. HIGH VOLTAGE SUPPLY VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS
		Note
TP1601	V 155	The readings taken at TP1601 and TP1602 are to be multiplied by 16
	R 5MEG	
TP1602	V -160	
	R 5MEG	

TABLE XXII. OSCILLATORS 1 AND 2 VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS						
		1	2	3	4	5	6	7
V2501	V	120	4.0	6.3*	0	4.5	4.0	120
	R	20K	9K	.2	0	620	9K	20K
V2502	V	35	0	6.3*	0	.55	0	35
	R	100K	0	.2	0	450	0	100K
V2503	V	100	-.35	6.3*	0	0	-.35	100
	R	15K	50K	.3	0	0		15K
V2504	V	24	0	0	6.3*	.2	0	24
	R	100K	0	0	.4	150	0	100K

* AC Volts
Test conditions:
Voltage; socket test adapters used, tube in adapter.
Resistance; socket test adapter used, tube removed at socket being tested, equipment power off.

TABLE XXIII. 160 MC I-F AMPLIFIER VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS						
		1	2	3	4	5	6	7
V2201**	V	0	.4	6.3*	0	147	75	.4
	R	0	∞	.6	0	∞	∞	∞
V2202**	V	0	1.3	6.3*	0	137	100	1.4
	R	0	∞	.6	0	∞	∞	∞
V2203**	V	0	1.3	6.3*	0	133	105	1.4
	R	0	∞	.6	0	∞	∞	∞
V2204**	V	0	1.3	6.3*	0	137	107	1.4
	R	0	∞	.6	0	∞	∞	∞
V2205**	V	0	1.5	6.3*	0	145	115	1.5
	R	0	100	.6	9	∞	∞	100
V2206**	V	0	1.5	6.3*	0	120	115	1.5
	R	0	100	.6	0	∞	∞	100
V2207**	V	0	.9	6.3*	0	150	115	.95
	R	0	68	.6	0	∞	∞	68
V2208***	V	0	.5	6.3*	0	150	70	.5
	R	1K	∞	.6	0	∞	∞	∞
V2209***	V	0	4.6	6.3*	0	150	125	4.8
	R	0	∞	.6	0	∞	∞	∞
V2210***	V	0	4.0	6.3*	0	145	130	4.0
	R	0	∞	.6	0	∞	∞	∞

* AC Volts
** Range selector switch in any position except "NARROW".
***Range selector switch in "NARROW" position.
Test conditions:
Voltage; amplifier secured in R. F. tuner, socket test adapters used for measurements, tube in adapter.
Resistance; amplifier removed from R. F. tuner, tube removed from socket under test.

TABLE XXIV. CONNECTOR, RESISTANCE MEASUREMENTS

CIRCUIT SYMBOLS	LOCATION	PIN NUMBERS														
		A 1	B 2	C 3	D 4	E 5	F 6	G 7	H 8	I 9	J 10	K 11	L 12	M 13	N 14	O 15
J1001	Indicator Drawer	∞			0	∞		∞	∞		∞	∞	∞			
J1002	Indicator Drawer			∞	0			200K		∞	80K	∞		∞	∞	∞
J1004	Indicator Drawer				0			200K			80K			∞	∞	
J1005	Indicator Drawer				0			200K						∞	∞	
J1006	Indicator Drawer				0			200K						∞		∞
J1008	Indicator Drawer				0			200K			70K			∞		∞
J1003	Indicator Drawer		0	∞	80K	∞	200K		∞							
P1005	Indicator Drawer	0	∞	∞												
J1601	High Voltage Supply	0	∞	∞												
J1602	High Voltage Supply	∞														
J1603	High Voltage Supply	∞														
J1604	High Voltage Supply	7MEG														
P1601	High Voltage Supply	6MEG														
P1201	1-MC I-F Amplifier				0			28K			350K			0	HTR	
P1102	64-MC I-F Amplifier				0			∞						0	HTR	
P1502	Sweep Freq. Generator				0			∞			1MEG			0		HTR
P1301	Power Supply & Video	∞		∞	0	100		70K		100	48K	100		100	100	100
P1302	Power Supply & Video	530K	530K		0	82K		70K	70K		48K		290K	290K		
P2201	160-MC I-F Amplifier	∞		∞	0	∞		∞		∞		∞		∞	HTR	
P1401	Spectrum Calibrator				0			∞		∞		∞		0		
J1401	Spectrum Calibrator	1358														
J2011	R-F Tuner Drawer	∞	0	0	∞	0	∞		0							
J2501	Oscillators 1 and 2	∞	0	0	∞	0	∞		∞							
J2504	Oscillators 1 and 2	∞														
J2505	Oscillators 1 and 2	∞														
J2503	Oscillators 1 and 2	∞														

TABLE XXV. 160-MC I-F AMPLIFIER INPUT AND OUTPUT JACKS, RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL	* SWITCH S2201 POSITIONS							
	1	2	3	4	5	6	7	8
J2201	1K	.1	∞	∞	∞	∞	∞	∞
J2202	∞	∞	.1	∞	∞	∞	∞	∞
J2203	∞	∞	∞	.1	∞	∞	∞	∞
J2204	∞	∞	∞	∞	.1	.1	.1	.1
J2205	51 ohms input for spectrum calibrator							
J2206	∞ ohms amplifier output (64MC)							

NOTE: * Starting with position 1 as the maximum counterclockwise position.

QUICK CHECK DATA FOR SENSITIVITY OF EACH UNIT. Table XXVI is included as an aid in quickly determining the overall sensitivity of the individual amplifier strips. It is advisable to check all amplifier strips before rejecting any one strip. Lack of indicated sensitivity in one strip may actually be due to the next strip in the sequence. The experienced technician will usually start at the Video input, J1302, and proceed to diagnose "backwards" to J2204.

Before utilizing Table XXVI it is necessary to preset the operating controls as follows:

1. "SPECTRUM WIDTH" at 10 mc (21, figure 2-1)
2. "SWEEP FREQ" at 30 cps (22, figure 2-1)
3. "VERT GAIN" at maximum (23, figure 2-1)
4. "I-F ATTENUATOR-DB" set at "O" (6, figure 2-2)
5. "SPECTRUM CENTERING" controls set at "O" (9, 10, figure 2-1)
6. "2nd I-F GAIN" for 1/16" noise display on CRT (26, figure 2-1)
7. "DET" switch at "SQ" (27, figure 2-1)

TABLE XXVI. (See figures 6-1 and 6-2.)

Amplifier	160 mc I-F	64 mc I-F	64 mc I-F	1 mc I-F	Video and Power Supply
Input to Strip	J2204	J1101	J1101	J1201	J1302
Frequency of Input Signal	160 mc**	160 mc**	64 mc*	64 mc*	1000 cps
Sensitivity	0.5-1.0 uv	4.5-6 uv	20 uv	200-350 uv	.3V. RMS***

NOTE: * Adjust input for 4 cm deflection of baseline. (Carefully peak signal generator at 64 mc.)
** Adjust signal input for a 2 to 1 signal + noise-to-noise ratio on CRT.
*** Input voltage to Video for 4 cm deflection.

SECTION VII

DIAGRAMS

7-1. GENERAL. The following diagrams are used for maintenance of the spectrum analyzer. The figure number and title of each are contained in the list of illustrations.

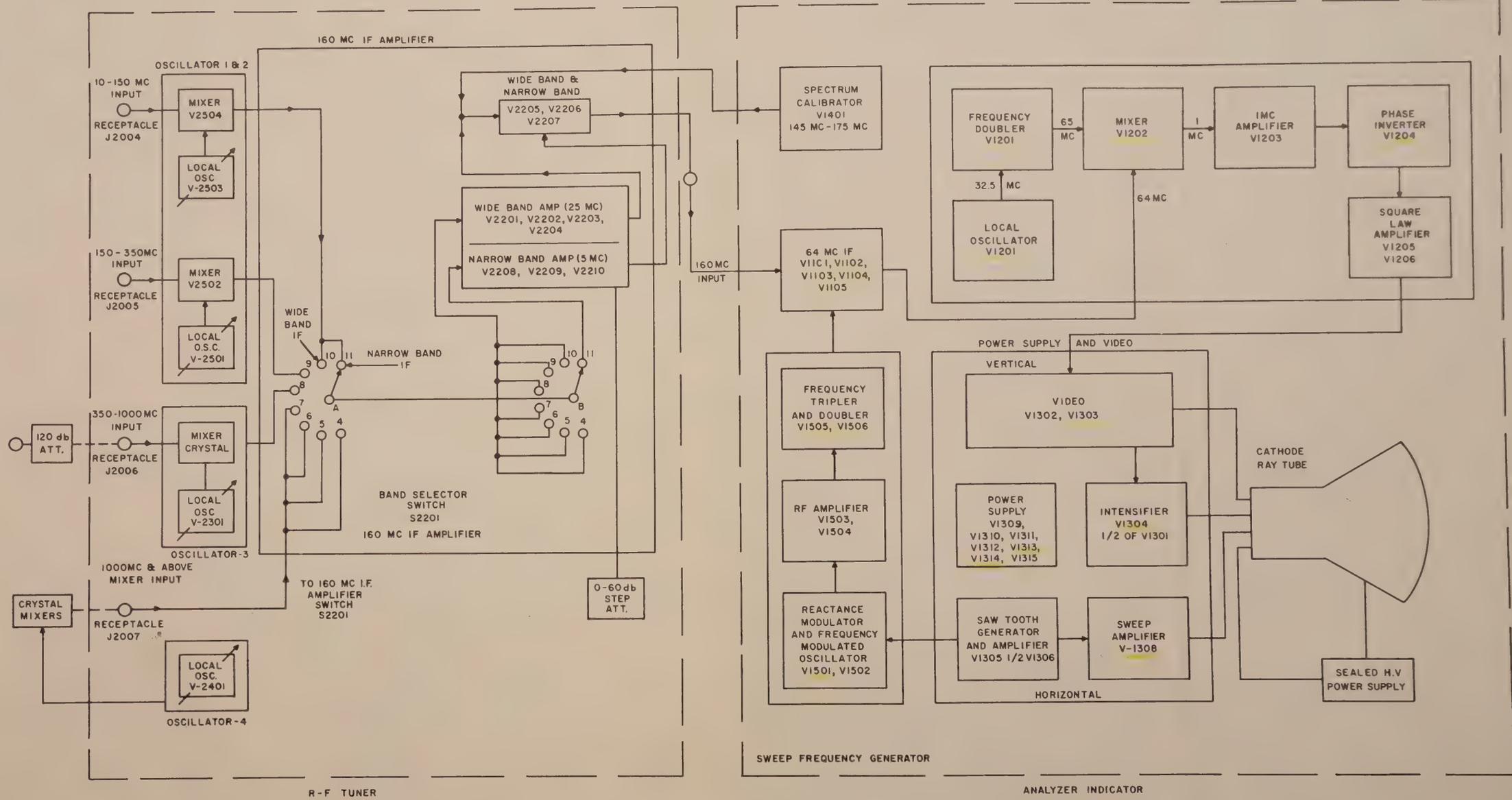


Figure 7-1. Functional Block Diagram

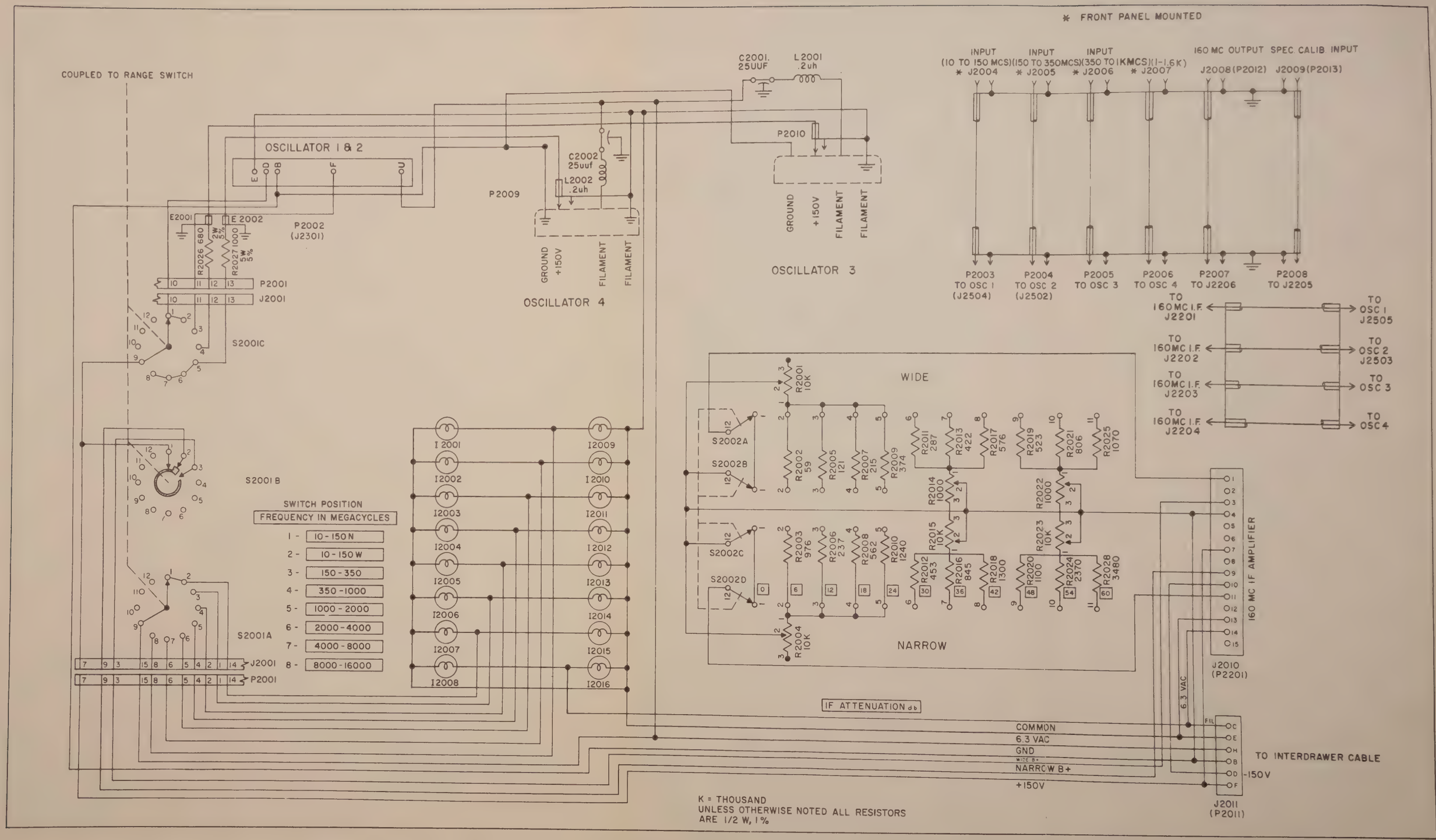


Figure 7-2. R. F. Tuner

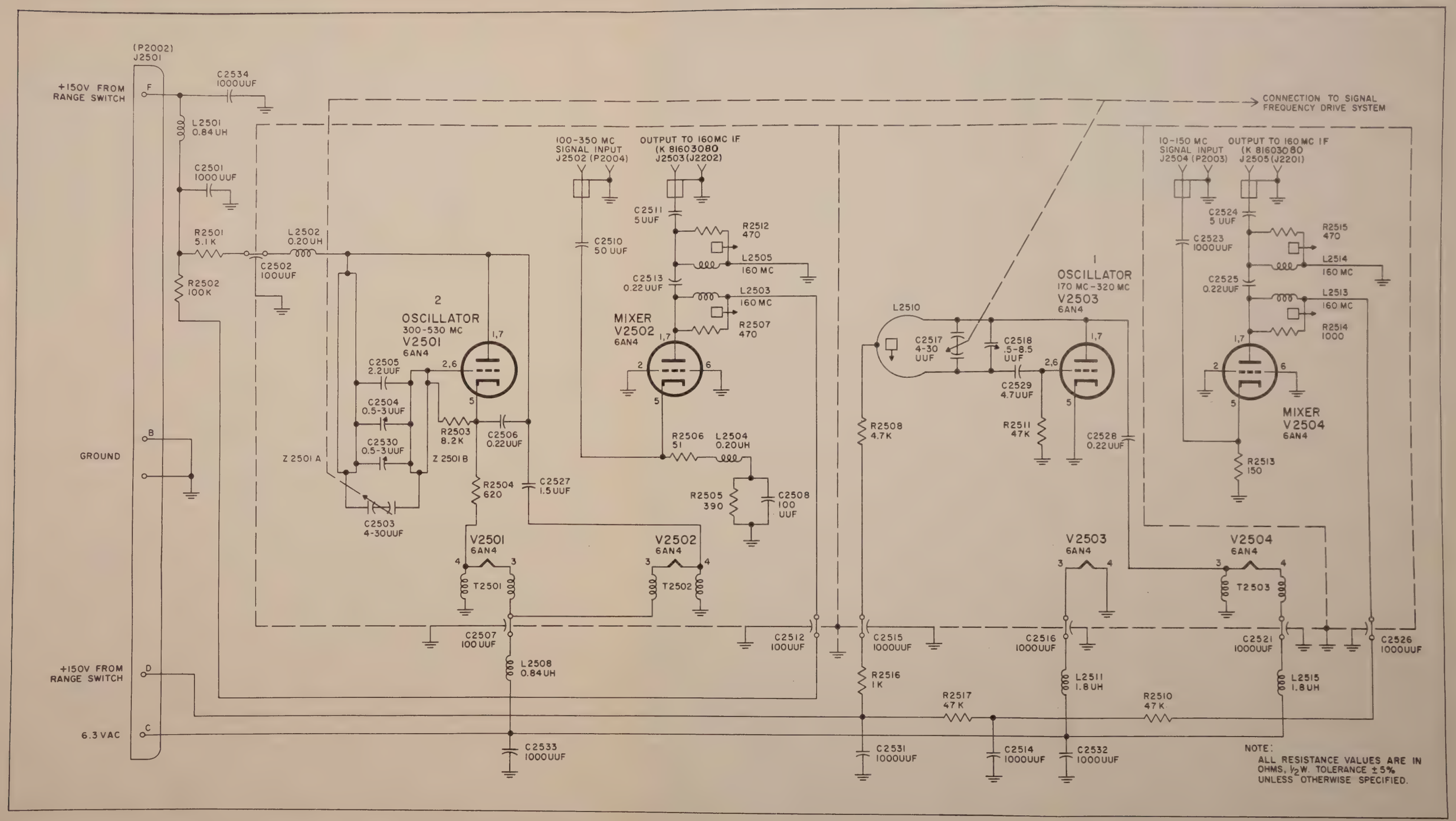


Figure 7-3. Oscillators #1 and #2

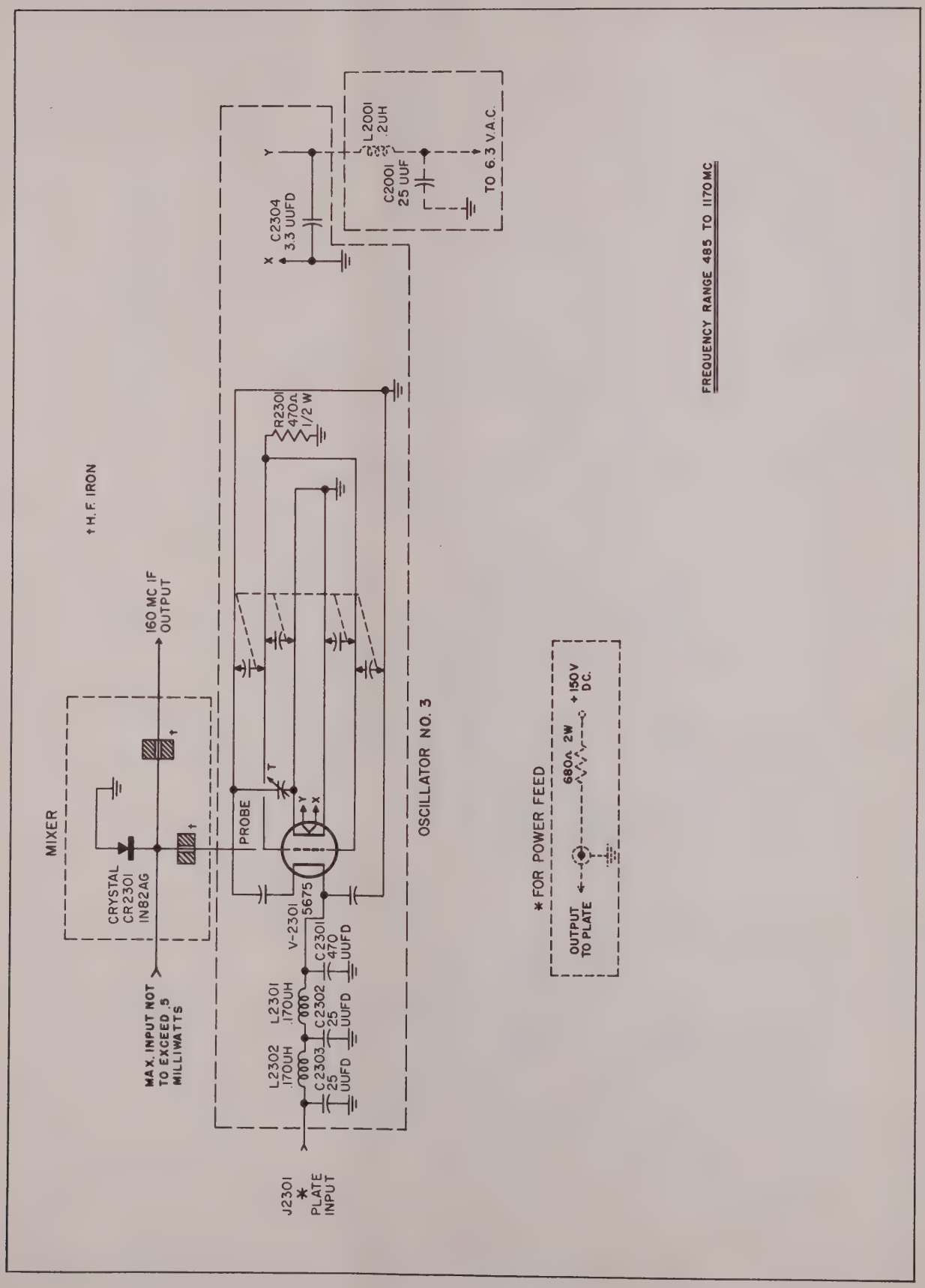


Figure 7-4. Oscillator #3 and Mixer

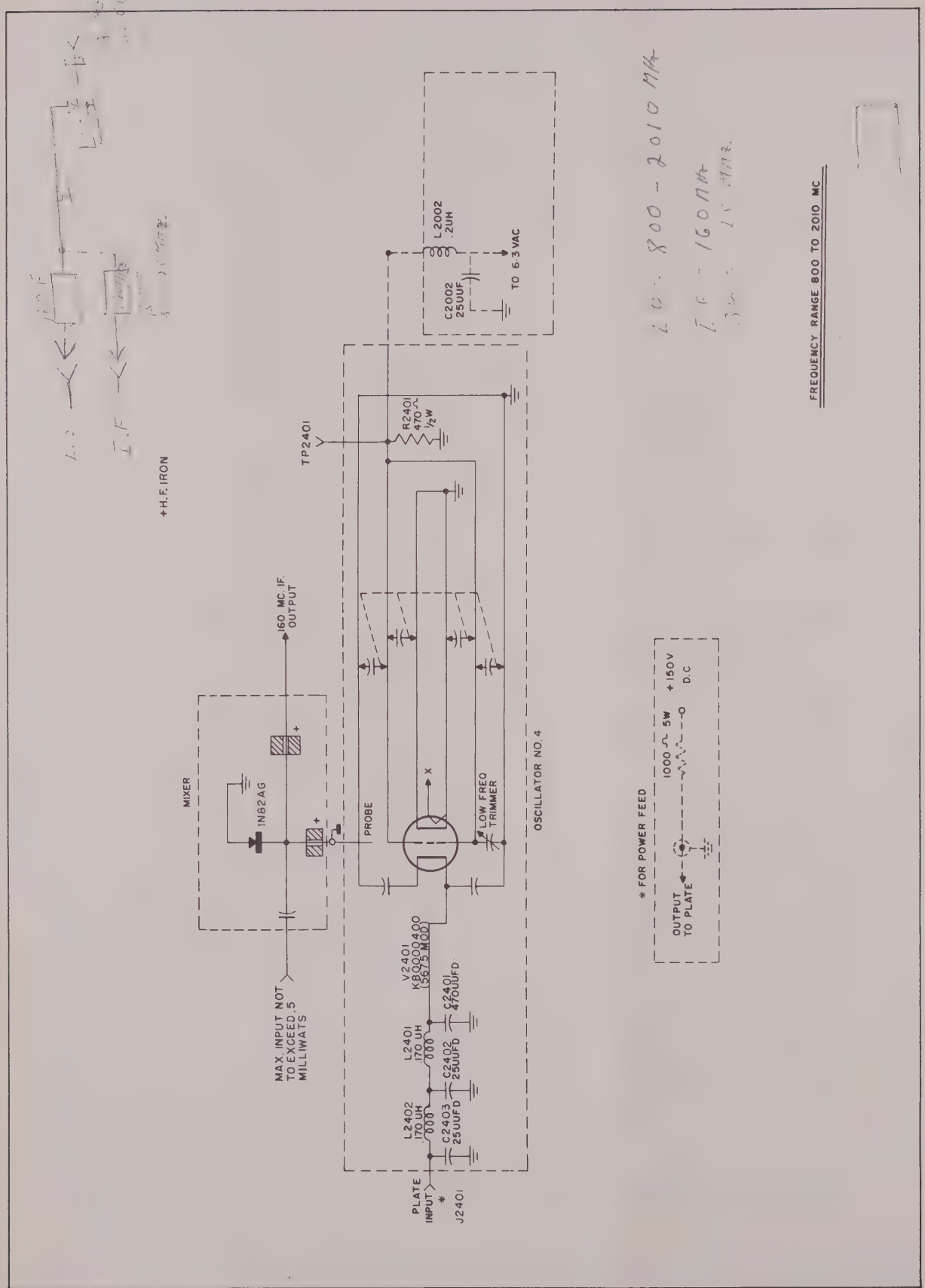


Figure 7-5. Oscillator #4 and Mixer

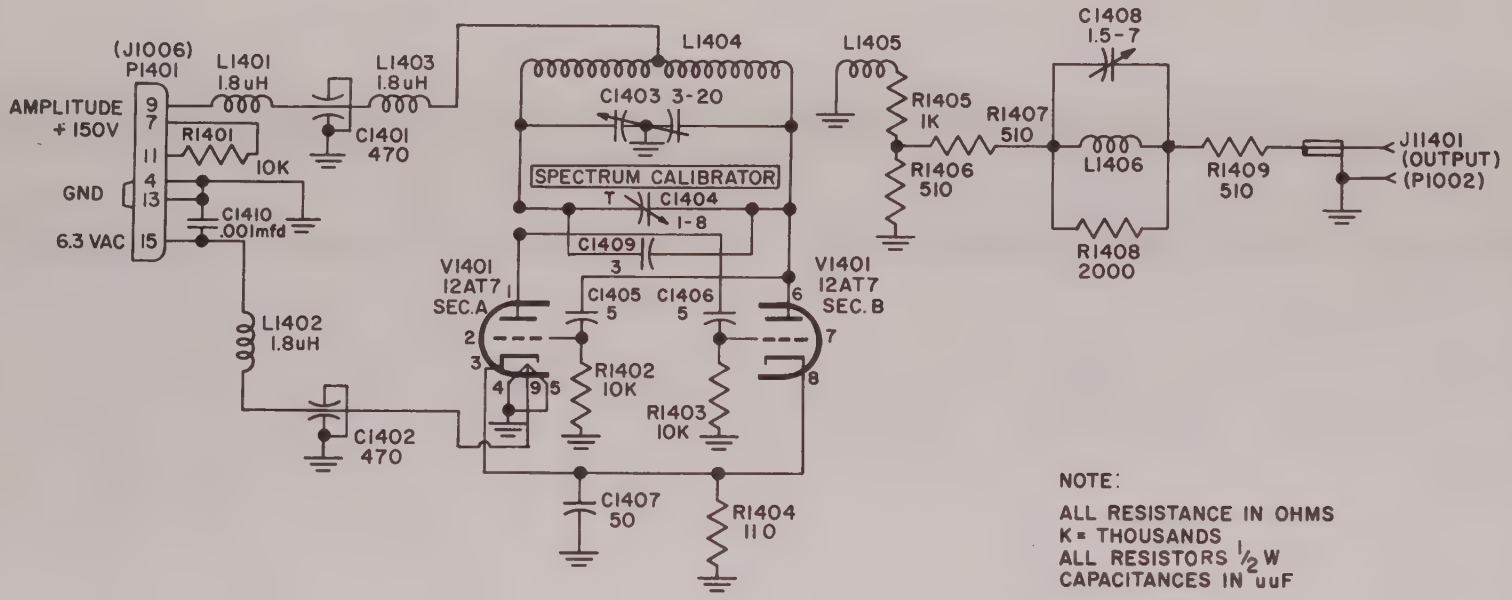
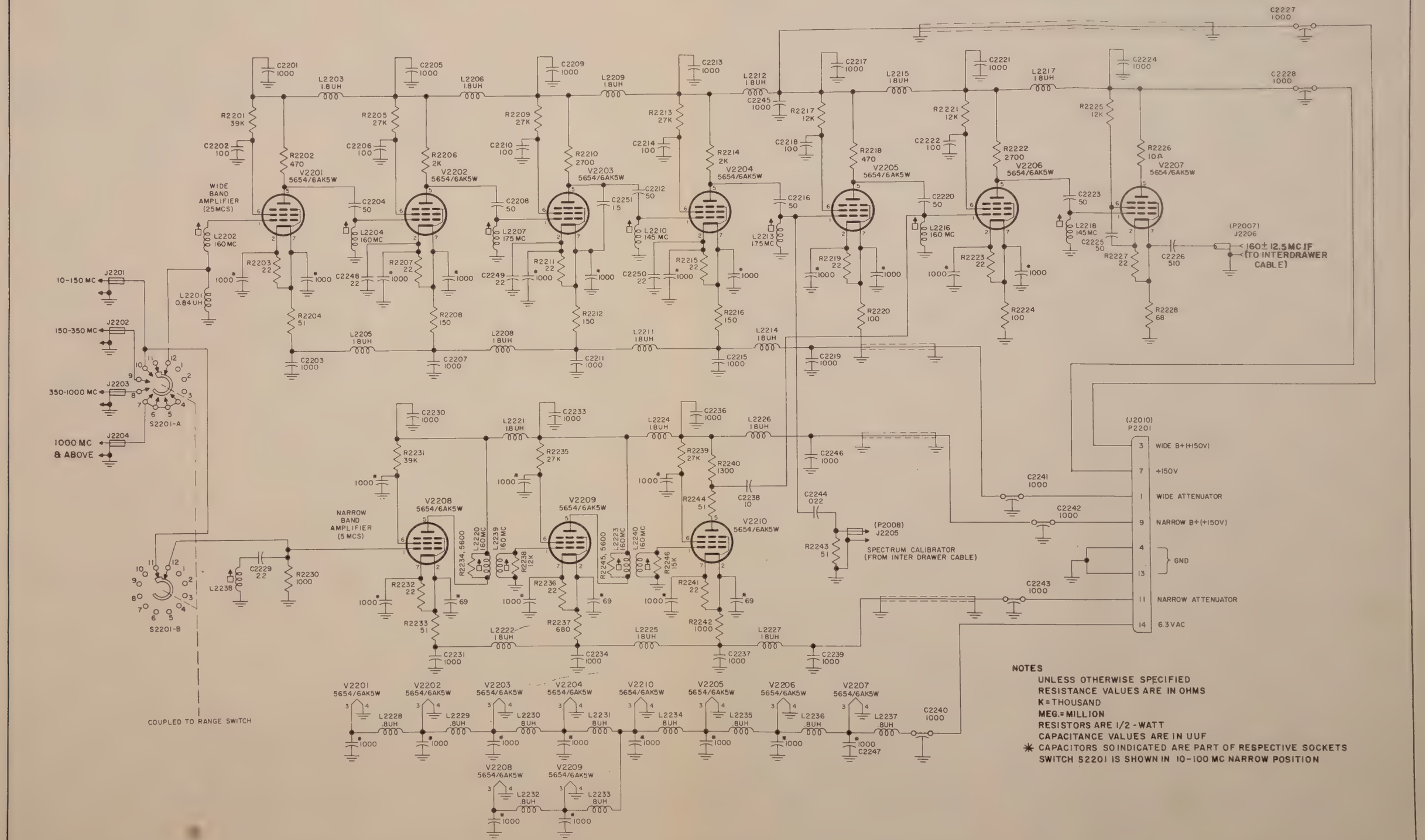


Figure 7-6. Spectrum Calibrator



NOTES
UNLESS OTHERWISE SPECIFIED
RESISTANCE VALUES ARE IN OHMS
K = THOUSAND
MEG. = MILLION
RESISTORS ARE 1/2-WATT
CAPACITANCE VALUES ARE IN UUF
* CAPACITORS SO INDICATED ARE PART OF RESPECTIVE SOCKETS
SWITCH S2201 IS SHOWN IN 10-100 MC NARROW POSITION

Figure 7-7. 160 MC I-F Amplifier

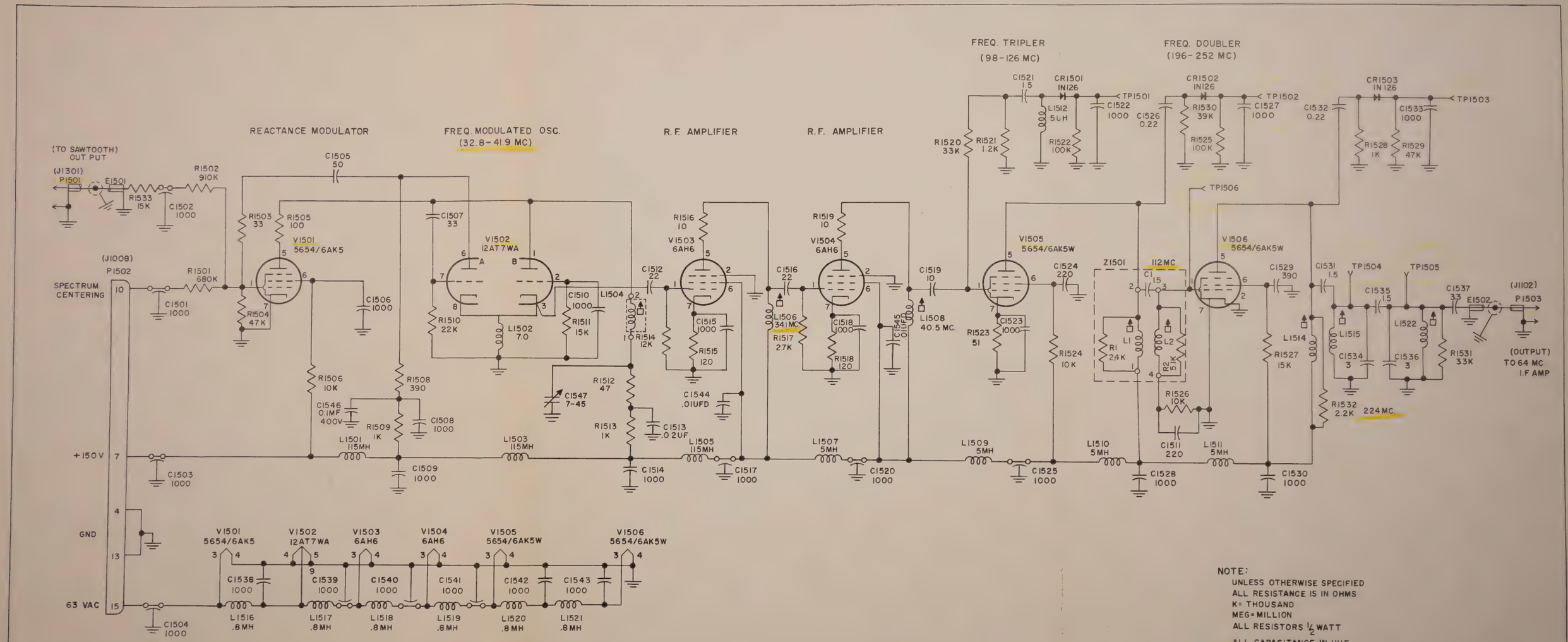


Figure 7-8. Sweep Frequency Generator

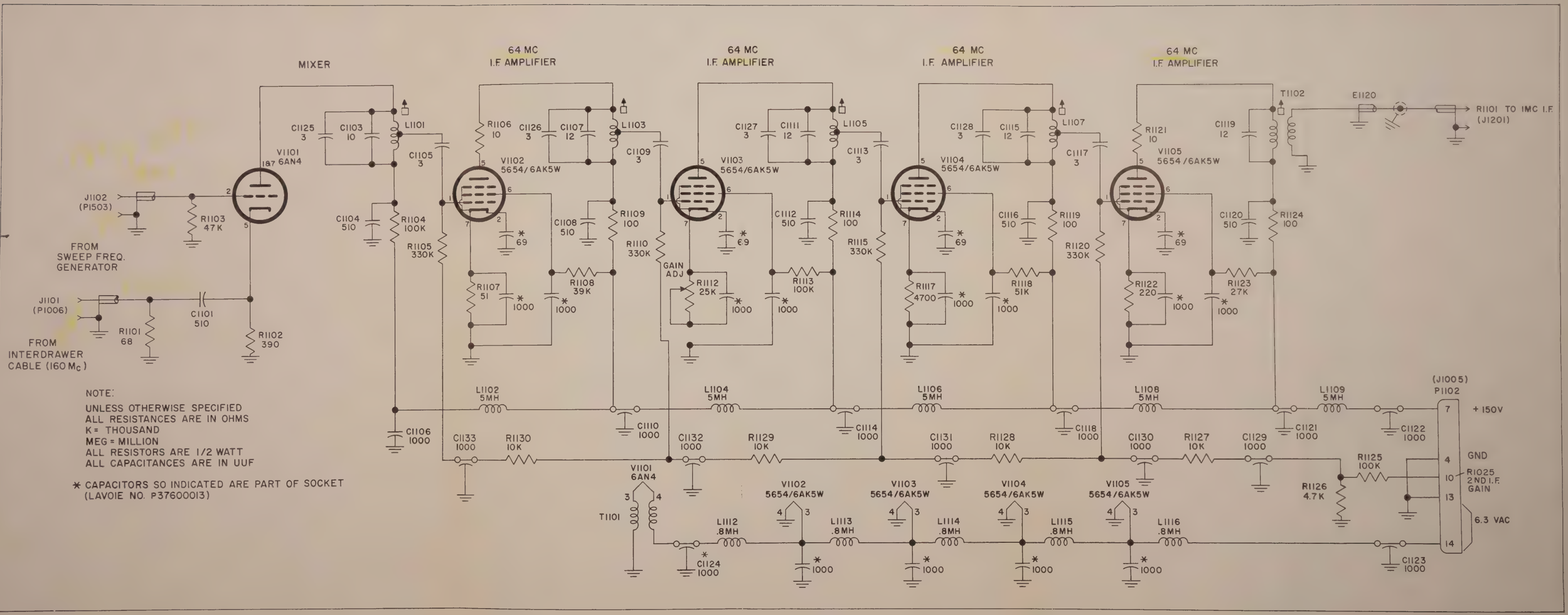


Figure 7-9. 64 MC I-F Amplifier

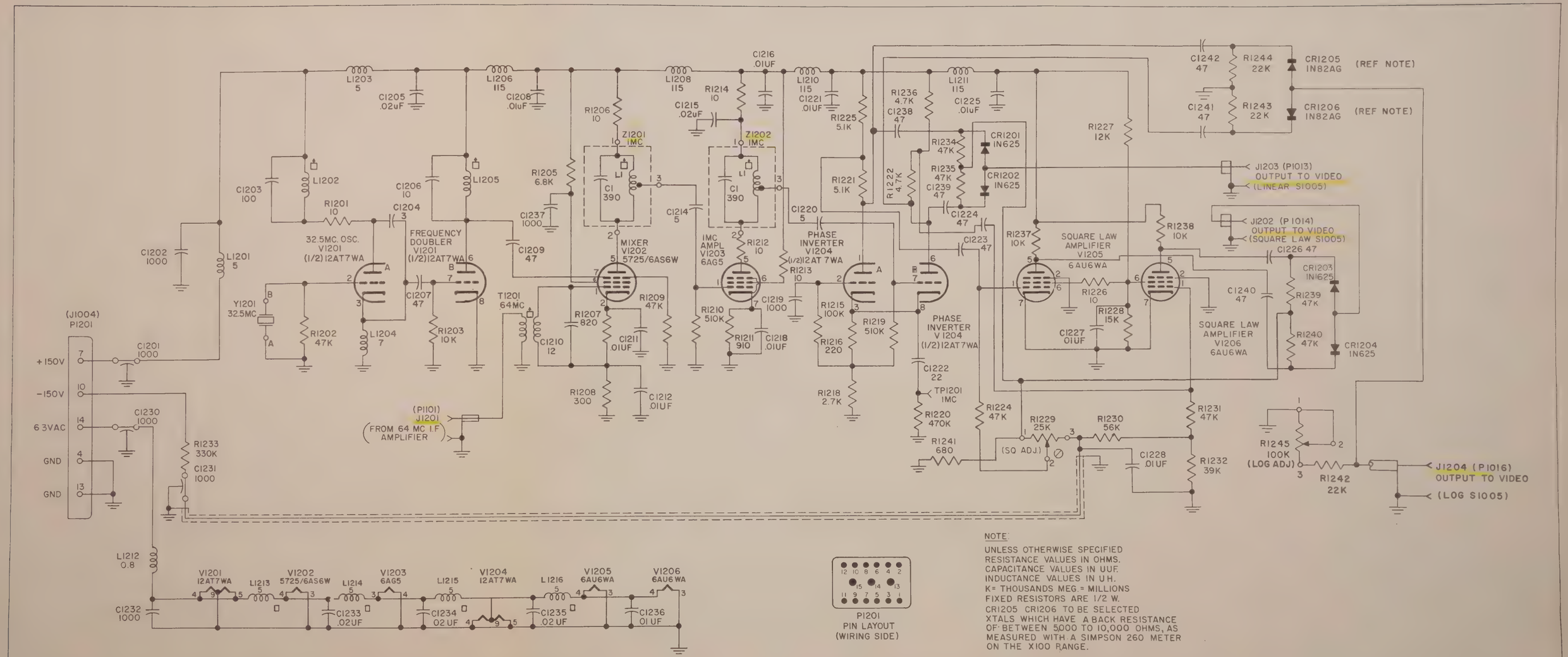


Figure 7-10. 1 MC I-F Amplifier (Early Models)

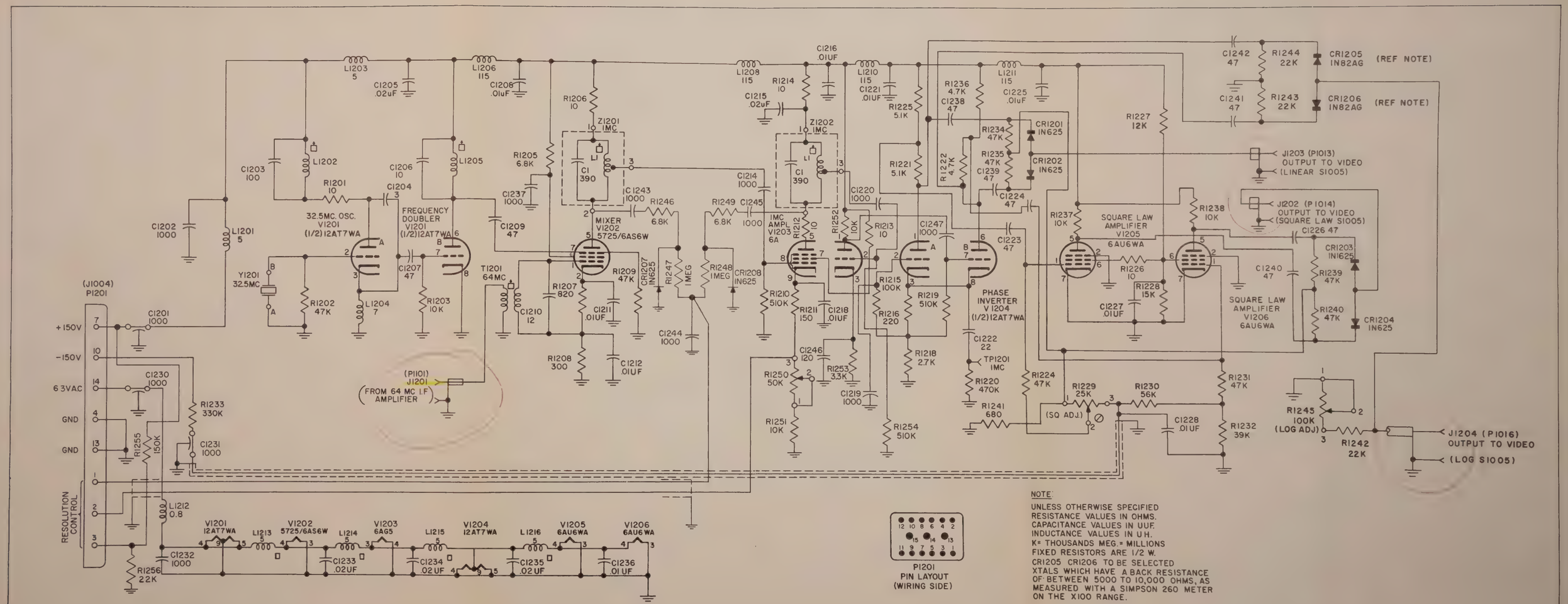


Figure 7-10A. 1 MC I-F Amplifier (Late Models)

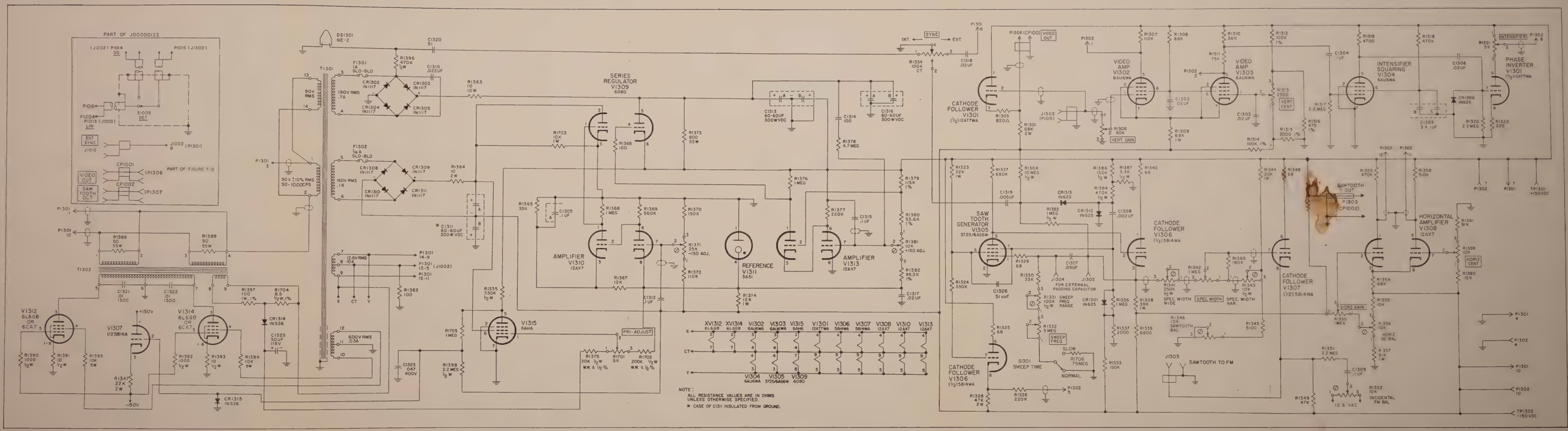


Figure 7-11. Power Supply and Video

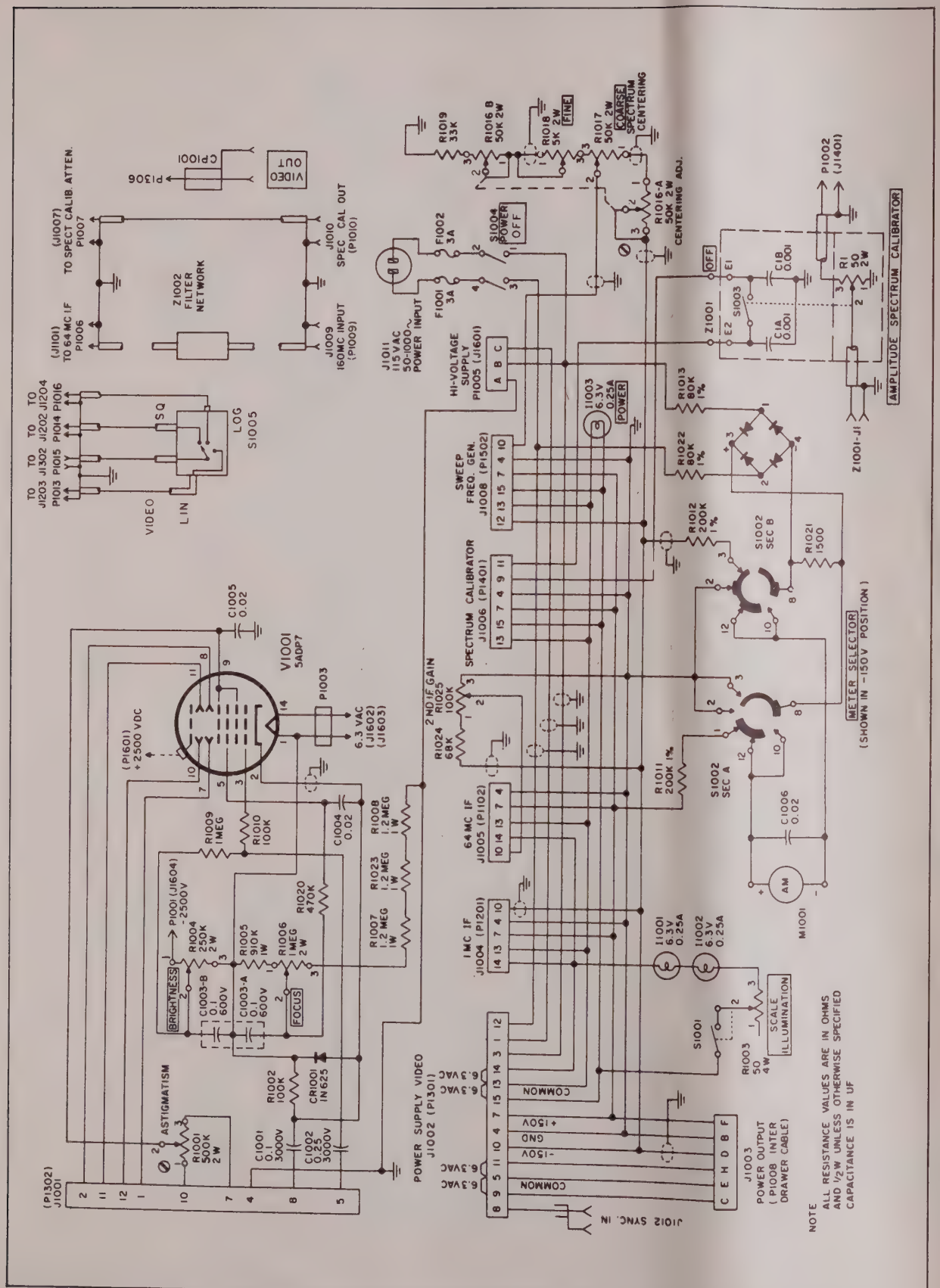


Figure 7-12. Indicator Drawer (Early Models)

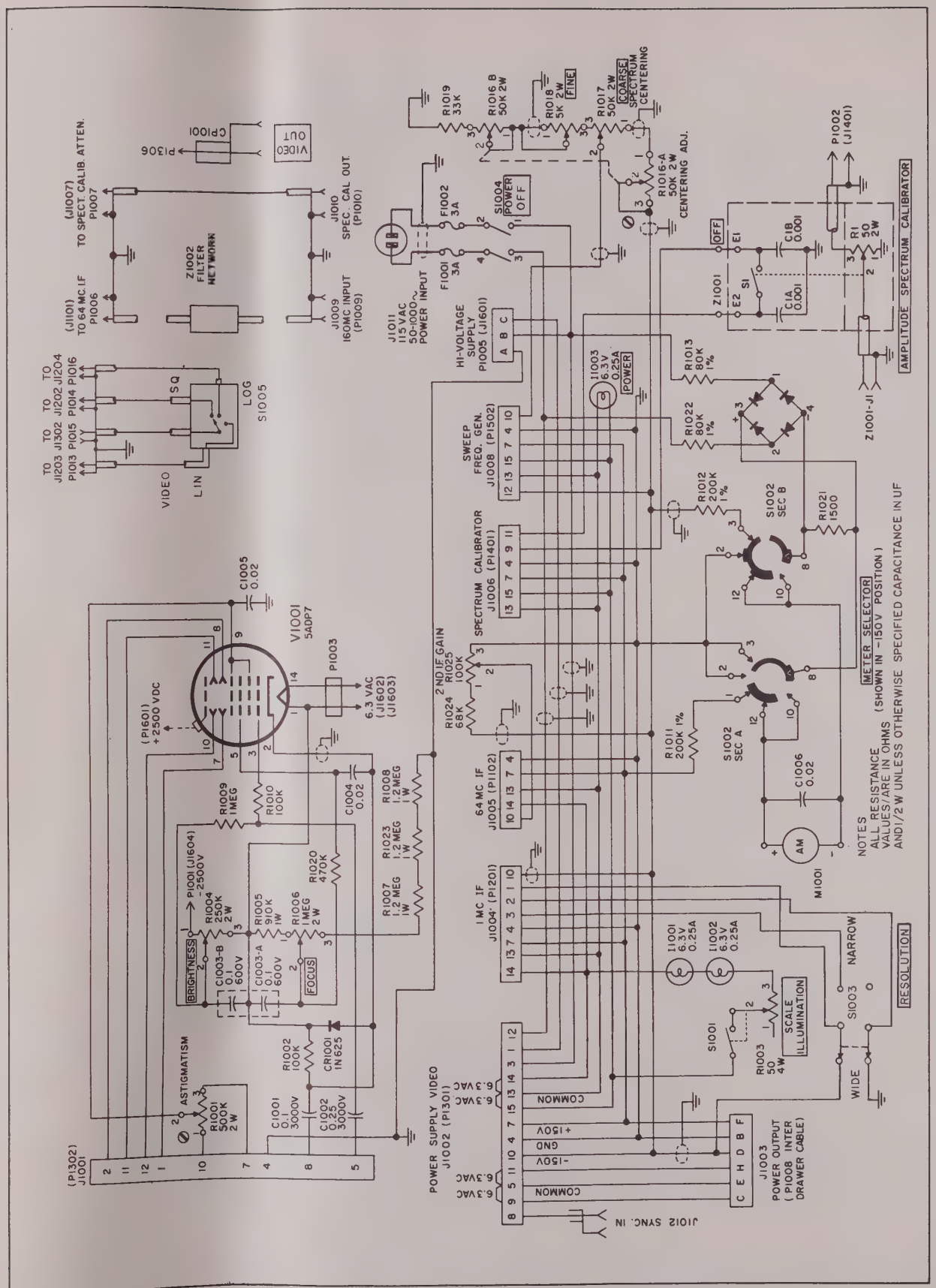


Figure 7-12A. Indicator Drawer (Late Models)

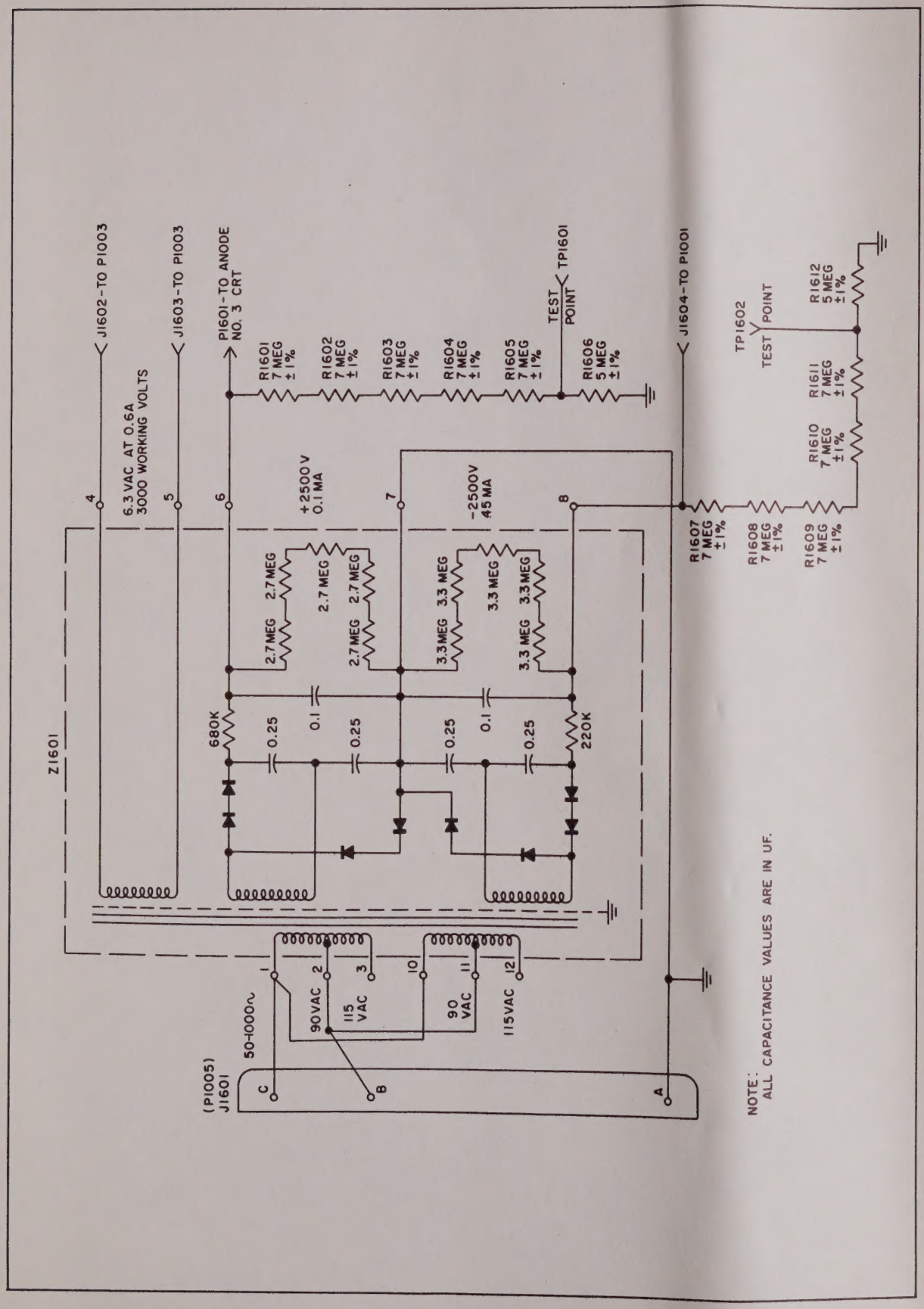


Figure 7-13. High Voltage Supply